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ABSTRACT

Reported was an evaluation of the life science program, Me Now, for the 11 to 13-year-old educable mentally handicapped child by comparing pretest and posttest scores of 180 subjects and 187 controls. Four to nine performance objectives for each of the following four units of the curriculum were evaluated separately: digestion and circulation; respiration and excretion; movement, support, and sensory perception; and growth and development. Results showed that students in the experimental group scored significantly higher on posttest scores than students in the control group on the first three units of the program. The evidence indicated that the desired student responses occurred when teachers followed the prescribed strategies. No control group was available for the fourth study unit but gains over pretest scores were reported to be far beyond the level expected. Also reported was a high level of teacher and student enthusiasm. Information gained from the evaluation was used to revise the materials. (For related curriculum materials, see also EC 050 872 through EC 050 875.) (DB)

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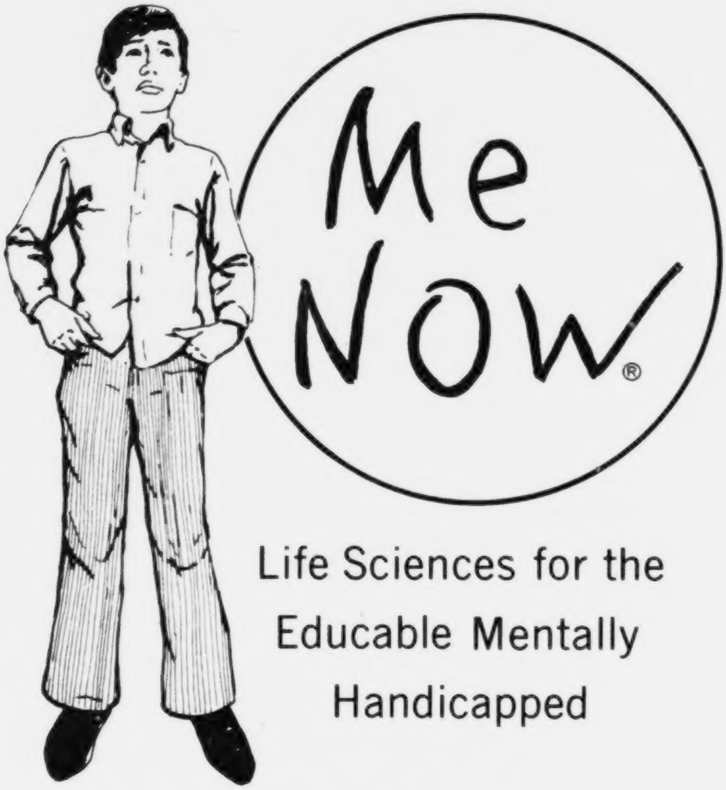
Bureau of Education for the Handicapped

A FORMATIVE EVALUATION OF



Life Sciences for the Educable Mentally Handicapped

Intermediate Grades (11-13 years)

Biological Sciences Curriculum Study
Richard R. Tolman December 1972

ED 071263

Final Report

A Formative Evaluation of *ME NOW*

Life Sciences for the Educable Mentally Handicapped

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Grant No. OEG-0-9-152075-3720(032)

Richard R. Tolman

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Biological Sciences Curriculum Study

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December 1972

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PREFACE

This report presents data and interpretations of data relevant to classroom trials of *ME NOW*, a life sciences program for the educable mentally handicapped prepared by the Biological Sciences Curriculum Study.

A vote of thanks is extended to Dr. James T. Robinson who assisted in preparation of Chapter I and the initial part of Chapter II and to Roy O. Gromme and Harold A. Rupert, whose comments and suggestions have been very helpful in the preparation of this report.

The completeness of the data reflects the dedication to the project of teachers in the experimental and control groups. The interpretations of the data are the sole responsibility of the project evaluators.

Richard R. Tolman

TABLE OF CONTENTS

Page No.

CHAPTER I. *ME NOW*, A LIFE SCIENCE PROGRAM FOR THE EDUCABLE MENTALLY HANDICAPPED

Introduction 1

The Curriculum 2

Philosophy of the Program 3

Performance Objectives 6

General Objectives 7

Basic Assumptions Underlying the Design of the Curriculum Materials 9

Design of the Formative Evaluation 13

Experimental Classes 15

Control Classes 16

The Student Group in the Evaluation Study 17

CHAPTER II. EVALUATION OF UNIT I, DIGESTION AND CIRCULATION

The Instructional Program 23

Effectiveness of Instruction: Data, Analysis and Interpretation 24

Objective 100. Students will associate foods with generalized body needs. 25

Objective 101. Students will associate food types with plant and animal sources. 34

Objective 102. Students will distinguish differences in physical characteristics of food. 39

Objective 103. Students will relate structure with function of mouth parts. 40

Objective 104. Students will relate location with structure and function of the esophagus. 48

Objective 105. Students will relate stomach functions to digestion. 51

Objective 106. Students will infer functions of parts of the circulatory system. 62

Objective 107. Students will infer a relationship between food and blood and describe barriers between them. 72

Objective 108. Students will observe and describe movement of solutions through membrane barriers. 79

Objective Achievement Tests 85

Descriptive Data and Interpretation 85

Multiple Stepwise Regression Analysis 89

Experimental Group, Unit I 89
Discussion 91

Objective Achievement Tests 93

Analyses of Variance and Covariance, Experimental Group, Unit I 93

Factorial Analyses, Experimental Group 96
Discussion 100

Experimental-Control Group Analyses 102
Discussion 103

Factor Analysis 103

Summary 105

CHAPTER III. EVALUATION OF UNIT II, RESPIRATION AND EXCRETION

The Instructional Program 107

Effectiveness of Instruction: Data, Analysis and Interpretation 108

Objective 200. Students will infer that breathing is a necessary life process. 108

Objective 201. Students will identify respiration as a necessity for body action. 124

Objective 202. Students will infer a relationship between waste and internal body processes. 141

Objective 203. Students will recognize, recall and be able to synthesize concepts presented in this unit. 155

Objective Achievement Tests 161

Descriptive Data and Interpretation 161

Multiple Stepwise Regression Analysis 165

Experimental Group, Unit II 165
Discussion 166

Analysis of Variance and Covariance, Experimental Group 168
Discussion 170

Factorial Analysis, Experimental Group 170
Discussion 174

Experimental-Control Group Analyses 175
Discussion 176

Factor Analysis 176

Summary 178

CHAPTER IV. EVALUATION OF UNIT III, *MOVEMENT, SUPPORT, AND SENSORY PERCEPTION*

The Instructional Program 179

Objective 300. Students will associate bones and muscles with body movement, support and balance. 180

Objective 301. Students will associate senses with conscious and unconscious control of body activity. 193

Objective 302. Students will associate the brain with control of body activity. 201

Objective 303. Students will associate sensory perception with learning and behavior. 213

Objective Achievement Tests 220

Descriptive Data and Interpretation 220

Multiple Stepwise Regression Analysis 224

Experimental Group, Unit III 224
Discussion 225

Objective Achievement Tests 227

Analyses of Variance and Covariance, Experimental Group, Unit III 227
Discussion 229

CHAPTER V. EVALUATION OF UNIT IV. GROWTH AND DEVELOPMENT

The Instructional Program 235

Effectiveness of Instruction: Data, Analysis and Interpretation 236

Objective 400. Students will associate sexual distinction with body parts and characteristics. 236

Objective 401. Students will identify and distinguish functional roles of organs related to sex. 241

Objective 402. Students will infer social roles related to sex. 248

Objective 403. Students will associate parental roles with the formation and development of a new individual. 249

Objective 404. Students will relate changes in life's continuum to human growth and development. 263

Objective 405. Students will account for the phenomena that have contributed to the development of *ME NOW*. 269

Objective Achievement Tests 273

Descriptive Data and Interpretation 273

Multiple Stepwise Regression Analysis 274

Experimental Group, Unit IV 274
Discussion 277

Objective Achievement Tests 279

Analyses of Variance and Covariance, Experimental Group, Unit IV 279
Discussion 281

Analysis of Variance, Experimental Group 281
Discussion 282

Factor Analysis 283

Summary 284

CHAPTER VI. SUMMARY AND CONCLUSIONS

What Were the Results of the Formative Evaluation? 285

What Were the Major Conclusions from the Evaluation? 288

What Were the Major Revisions Suggested for the Revised Materials? 290

Summary 291

CHAPTER I

ME NOW, A LIFE SCIENCE PROGRAM FOR THE EDUCABLE MENTALLY HANDICAPPED

Introduction

This report presents data and interpretations of data that describe the results of classroom trials of the BSCS Life Sciences for the Educable Mentally Handicapped, Intermediate Grades Program, developed with funds from the U. S. Office of Education, Bureau of Education for the Handicapped. Detailed description of the instructional materials, the curriculum rationale, and other facets of the project have been described in BSCS Newsletters 36, 38, 43 and 46. Copies of the Teacher's Guide are available from Hubbard Scientific Company.

Classroom trials of Unit I, Digestion and Circulation, were conducted in the spring of 1970. The formative evaluation of these materials has been briefly reported by the Biological Sciences Curriculum Study.[1,2]

This report describes the formative evaluation of the classroom trials of Units I, II, III, and IV conducted during the school year 1970-71. The Unit I Teacher's Guide was revised for this evaluation study and revised data collection instruments were developed. Revisions

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[1] Richard R. Tolman and James T. Robinson. "Formative Evaluation of Unit I, Digestion and Circulation." BSCS Newsletter 43:7, 21 (April), 1971.

[2] James T. Robinson and Richard R. Tolman. A Formative Evaluation of ME NOW Unit I, Digestion and Circulation. Boulder: Biological Sciences Curriculum Study, September 1970, 97 pp. (ED 043182)

were based upon recommendations suggested by Robinson and Tolman. Units II, III, and IV were developed in the summer of 1970 and were tried in classrooms for the first time in 1970-71.

The completeness of the data reflects the cooperation of the experimental and control group teachers and the extensive efforts of Harold A. Rupert, Jr., and Roy Gromme, BSCS Staff Consultants, in visiting classes and working directly with the trial teachers. The interpretations of data are the sole responsibility of the evaluation staff.

The Curriculum

The materials of the *ME NOW* program consist of a Teacher's Guide that presents suggested teaching strategies and all of the associated materials needed by teachers and pupils. There is no student text as the program relies heavily on activities supported by a variety of instructional materials. These include 35mm daylight projection slides, individual pupil worksheets, charts, models, films, laboratory equipment and evaluation instruments.

The initial field-test materials were designed and structured to conform to a particular philosophy, a set of general objectives, and some basic assumptions. The validity of all of these is questionable to some degree, simply because of the limited knowledge available regarding special education curriculum construction and because of the unsolved problems facing all educational endeavors--especially those in special education. Among these problems are:

--the variability of the population described as mentally handicapped.

--the limitations of instruments and judgments used to assign pupils to EMH classes.

--the problem of low teacher expectations (and low pupil self-image).

--the lack of existing guidelines or exemplars of effective materials for curriculum design for this population.

--the complexities of conceptual frameworks in science as they are represented by the discipline.

--disagreement among curriculum workers concerning the use and value of behavioral objectives.

--lack of consistency among evaluation models.

--limited teacher knowledge of science and experience with science materials and procedures.

In spite of these problems, the BSCS staff proposed to establish and to work within a "reasonable" framework of hypotheses regarding what is possible to achieve, and to modify this as experience dictates. This framework is contained in the philosophy and general objectives established for the project.

Philosophy of the Program

All children are entitled to equal opportunities for self-development to the fullest extent of their individual physical, mental and emotional capacities. Because children with mental handicaps do not have the same ability to adjust and to learn effectively in the usual classroom as do so-called normal children, they should be provided with instructional programs specifically designed for their needs and abilities. Meeting those needs--and determining those abilities--requires the provision for learning experiences that make it possible for handicapped children to achieve both mastery of useful concepts and a sense of personal satisfaction with the learning experience.

Throughout the program, students should confront real phenomena in such ways that their curiosity is aroused and the desire to investigate further is encouraged. It is not always feasible, however, to allow each student full freedom to discover knowledge for himself. There are problems of classroom management to gain the fullest opportunity for every child. These materials, therefore, were structured to provide the stimulus to curiosity and then to guide students through inquiring kinds of activities; such as observing, describing, identifying, comparing, associating, inferring, applying and predicting.

The application of inquiry methodology to the learning activities of EMH students is still largely based on intuition. However, preliminary observations of the strategies proposed in this project seem to indicate that students are, in general, highly motivated and that learning does occur. Until sufficient evaluation data are obtained, prejudging the extent or limits of the student's ability to learn through inquiry is to be avoided. The student should be given the opportunity to perform in these modes to the highest level of effectiveness he can attain.

Two hierarchies are presumed to exist in the materials. One pertains to a level of cognitive difficulty and the other to a logic for the sequencing of content elements.

The staff and committees have considered and accepted, for this curriculum effort, one hypothesis with respect to the relationships between inquiring behaviors (or performance objectives) and cognitive difficulty. This hypothesis is expressed in Figure 1.

4	Applicational	Predicting Applying	Highest
3	Relational	Inferring Associating	
2	Conceptual	Comparing Identifying	
1	Perceptual	Describing Observing	Lowest

Figure 1. Presumed Levels of Cognitive Difficulty

Although performance objectives and classroom behavior may range across the four levels of difficulty without overt limitation, it is assumed that the EMH child will profit from a design that proceeds--where possible--from simple to complex, from concrete to abstract, from external to internal, from what is familar to what is unfamiliar. However, depending on the nature of the content, a child may, for example, be expected to associate ideas or objects that are familiar to him without first describing them.

It is also assumed that the child should be allowed to study single elements of a system before being asked to consider interactions of those elements. Similarly, a child might be expected to focus on the functions of an element before he is expected to associate a name with those functions.

Until decisive data to the contrary are obtained, it is assumed that the EMH child is able to perform effectively across the four levels of complexity, but within a reasonable range of difficulty commensurate with a high percentage of individual motivation and success.

Performance Objectives

A major commitment of this project is to specify performance objectives for the EMH pupil population and to design activities through which these objectives are to be attained. The specification of objectives is influenced least by biology, and most by the EMH pupil population. Biology is a source of information about life and a source of understanding of the methods by which this information is obtained. But there are perceptual, emotional and other learning difficulties as well as practical considerations for the welfare of these children in a competitive and often indifferent society. A reasonable mix of these considerations was sought in order to provide a useful, meaningful and effective curriculum in life science for the educable mentally handicapped. The content is not to be pursued to a depth greater than the ability or need of these children to absorb it. Nor will these students be involved in intellectual operations beyond their abilities to perform. These limits are not readily identifiable and both optimism and restraint must be applied to the development of reasonable hypotheses in this regard.

The selection and statement of performance objectives for this program represent an effort to specify (1) those content elements that represent a reasonably complete picture of structure-function relationships, (2) cognitive and psychomotor operations the student will perform during instruction; and (3) what the student will know, or be able to do on his own when an activity sequence is completed. Individually and collectively, these three factors represent the bases upon which the effectiveness of the materials and the instruction on the learning of the child should be evaluated.

The model for inquiry used in these materials demands that the focus of classroom activity be on the student with materials and activities. The teacher functions as a catalyst in generating pupil responses in the learning situation. The response desired may be attitudinal, cognitive or psychomotor, verbal or non-verbal. The teacher's behavior also falls in these same categories, but with an important difference: The teacher must be totally conscious of her role as stimulant while the student is generally unaware that he is being manipulated by strategy.

To communicate maximally with the novice teacher, or the experienced teacher who is willing to be led through a structured program, as much as possible of the pattern of interaction upon which the anticipated results depend is carefully described. Teachers often fail to allow children the opportunity or the time to think for themselves when a problem is posed. They also frequently impose their observations and interpretations on children rather than allow the children to express their own views of things observed. Therefore, teachers are provided a model of strategy in these materials that will--if initially studied and used--demonstrate the benefits we describe for it in terms of pupil response behavior.

All that will occur with individual students in the classroom cannot be predicted, but enough reminders are provided to teachers to enable them to deal with unexpected or unpredicted events in the same mode in which the materials are written.

General Objectives

1. To help the child develop interests, skills, and positive attitudes through experiences with science and biological concepts.

2. To provide the child with challenging intellectual activity at a level commensurate with his ability to respond effectively.
3. To aid the child in establishing acceptable and functional modes of living through heightened powers of observation, a well-developed curiosity, a good measure of self-confidence, and a sense of responsibility to and for his environment.
4. To contribute to the development in the child of a high level of social maturity and emotional stability that can lead to increased vocational proficiency, realistic self-concept, creative self-expression, and more effective assimilation into the community.
5. To develop in the child a knowledge of himself in relation to his environment, as well as a tendency to apply this knowledge to the tasks of everyday living.
6. To contribute to increased knowledge about the learning characteristics and limitations of the educable mentally handicapped pupil, and about effective strategies for instruction.
7. To assist the teacher in developing a classroom atmosphere and instructional modes most conducive to the attainment of these objectives.

To further narrow the range of possible development strategies, a set of tentative assumptions that would serve as criteria for curriculum design was prepared. Whether factual or not, these assumptions were considered acceptable by the committees of teachers and specialists who have been instrumental in reviewing and testing the materials.

Basic Assumptions Underlying the Design of the Curriculum Materials

1. Most teachers of the educable mentally handicapped will need specific direction in the use of inquiry strategies in the teaching of science concepts.
2. EMH children need and can respond effectively to an activity-centered instructional approach.
3. To achieve the objectives, materials should maintain a balance between detail and motivation, for the amount of minute and abstract detail that can be learned is probably a function of the interest and motivation that can be established to deal with it.
4. The classroom environment and the materials should be uncluttered with distractors; however, a variety of perceptual modes and instructional media should be used in all efforts at communication (e.g., sight, touch, smell, etc.).
5. An activity must involve the student in ways of applying the desired behavior; transfer, cannot be assumed.
6. Activities should be developed in small, discrete units that build on or reinforce a concept or skill.
7. Entry points should be concerned with concrete, tangible "things" rather than with abstract, intangible ideas or concepts.
8. Ideas must be developed without the _necessity_ for reading on the part of the student.
9. Vocabulary, where possible, should involve _functional_ language rather than technical terms.

Table 1. Formative Evaluation Model

Antecedents: Conditions existing prior to teaching and learning that may be related to outcomes.

Questions	Intentions	Data to be Collected	Data Collection Source	Instruments to be Developed	Method of Data Processing
1. Did students in test classes have characteristics of the population for whom the materials were developed?	Students in test classes will be ages 11 to 13 years with total IQs from 50 to 80.	Student age, IQ, race, teacher's assessment of reading level & verbal participation	School records, teacher judgments	Data collection form	Computer: Descriptive statistics (BMD01D)
2. Can the student perform the objective prior to instruction?	Students will respond to most test items in random fashion on pretest.	Pretest over objectives	Parallel forms of a multiple choice test	Forms A & B of test over objectives	Computer: Item analysis & Descriptive statistics FORTAP program

Table 1. (cont'd.)

Transactions: The encounters of student with teacher, student with materials, teacher with materials, and student with student.					
Questions	**Intentions**	**Data to be Collected**	**Data Collection Source**	**Instruments to be Developed**	**Method of Data Processing**
3. Did the teacher use the strategies as prescribed?	Teachers will use the strategies and add to them when necessary.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program
4. Did the teacher modify the strategies?	Teachers will not modify, but will supplement selected strategies.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program
5. How much time is devoted to a particular block or unit of material?	4-6 weeks at 30 minutes per day should be adequate for each unit.	Teacher reports	Teacher	Report form	Hand compiling
6. Did the intended student behavior occur?	Students will be able to perform the intended behaviors.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program
7. Did the intended student behavior occur to an acceptable degree?	Students will want to perform the activities presented in the materials.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program
8. Did unintended behaviors occur?	Lack of interest and inability to perform will be limited to a few students in each class.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program
9. What was the behavioral relationship between teacher and student?	Prescribed teacher behaviors will elicit desired student responses.	Teacher reports Classroom visits	Teacher BSCS staff	Report form	TALLYEX program

Table 1. (cont'd.)

Outcomes: The impact of instruction on teachers, students, administrators and parents.

Questions	Intentions	Data to be Collected	Data Collection Source	Instruments to be Developed	Methods of Data Processing
10. What were teachers' reactions to materials?	Teachers will respond critically to each of 16 sections of materials.	Teacher reports	Teacher	Report form	TALLYEX program
11. What were teachers' reactions to teacher strategies?	Teachers will support inclusion of strategies (with modifications) in the Guide.	Teacher reports	Teacher	Report form	TALLYEX program
12. What were the students' reactions to the materials?	Teacher will report on student reactions in terms of attention, interest & performance for each of 16 sections of materials.	Teacher reports	Teacher	Report form	TALLYEX program
13. What were the students' reactions to teacher strategies?	Students will perform instructional objectives and will show gains on posttest scores.	Teacher reports Pretest-Posttest scores	Teacher Forms A & B Pretest & Posttest	Report form Multiple choice tests	Computer: TALLYEX,FORTAP programs. ANCOVA, multiple stepwise regression,residual gain,descriptive statistics, ANOVA
14. Did the students meet the objectives?	Each student will perform the instructional objectives; a high percentage will be able to perform as stated.	Pretest-posttest scores Teacher reports	Forms A & B Pretest & posttest Teacher	Multiple choice test Report form	Computer: FORTAP program, ANCOVA, multiple stepwise regression, residual gain, descriptive statistics, ANOVA
15. Did students meet objectives to a suitable degree?	Each student will attain a posttest score similar to a predicted score.	Pretest-posttest scores	Forms A & B Pretest & posttest	Multiple choice tests	Computer: FORTAP program, ANCOVA, multiple stepwise regression, residual gain, descriptive statistics, ANOVA

10. For the EMH student to learn, the instructional approach must be slow-paced and redundant, and there must be time for participation by each student.
11. Efforts to describe the "average" EMH child are essentially futile because of variability within the population; therefore, materials and methods should allow for attention to individual differences and needs.

Policy committees, working within the constraints of the program philosophy, general objectives, and assumptions, prescribed an initial focus on the following content areas:

Part I: *ME NOW*, Structure and Function

Unit I,	Digestion and Circulation
Unit II,	Respiration and Excretion
Unit III,	Movement, Support, and Sensory Mechanisms
Unit IV,	Growth and Development

Later units are to explore a variety of environmental and ecological concepts. This report presents the results of the classroom trials of the four units listed above.

Design of the Formative Evaluation

The design for classroom testing of the four units of study proposed in a summer writing conference (1970) is presented in Table 1. This design followed that used in the initial study of the efficacy of Unit I, as described by Robinson and Tolman.[3] The design is an adaptation of the formative evaluation model proposed by Stake.[4]

The design presented in Table 1 included as many recommended changes as were possible within funding limits. Unfortunately, the funds recommended for observation and data gathering of teacher-student transactions were again eliminated from the budget.

Support for providing 16 classes with the experimental materials precluded any significant prospect for random selection of trial classrooms. In addition, there were several important considerations for selection of specific classes at the current stage in the development of the curriculum materials:

1. representation of youngsters in cities, suburbs, and rural environments;
2. location near universities with active faculty interest in improving instruction for the educable mentally handicapped;
3. clustering at least two classrooms in close geographic proximity to reduce costs of staff visitation and to permit rapid exchange of shared materials.

Sixteen experimental and sixteen control classes were selected for the 1970-71 formative evaluation study. Experimental group teachers administered pretests prior to instruction for each unit and posttests after the instruction for each unit was completed. Pretesting for Unit I, in both experimental and control classes, was conducted in the first week of November, 1970. As experimental group teachers proceeded at their own rates, test administration after the first pretest varied considerably.[5] Control groups administered pretesting and posttesting on a regular schedule.[6] A parallel form test design was used, as shown in Table 2.

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[3] Ibid.

[4] Robert E. Stake. "The Countenance of Educational Evaluation." Teachers College Record 68:523-540 (April), 1967.

Table 2. Data Collection Program for Each of Four Units of the *ME NOW* Program

Group	Pretest	Treatment	Posttest	Other Data
Experimental 16 classes	8 classes Form A	BSCS *ME NOW*, Unit I, II, III, or IV	8 classes Form B	Student characteristics Teacher report form
166 students	8 classes Form B	Teacher report forms	8 classes Form A	Classroom visits by BSCS staff
Control 16 classes	8 classes Form A	Regular curriculum No reports	8 classes Form B	Student characteristics
168 students	8 classes Form B		8 classes Form A	

Experimental Classes

One classroom in Boulder, Colorado, was selected for trial use of the *ME NOW* Program to provide easy access to the development staff and to the many U. S. and foreign visitors who visit the Biological Sciences Curriculum Study. Three additional Colorado classrooms, two in the Denver area and one in Pueblo, were selected to provide for a diversity of classroom conditions within driving distances of the BSCS offices. The two Denver area classrooms were also convenient for visitation and research participation by graduate students from the University of Denver.

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[5] This variation will be considered with the discussion of each unit.

[6] See Appendix I.

Two classrooms were selected in Des Moines because of the interest of the Division of Special Education of the Iowa State Department of Education, and the desirability of testing in the Midwest.

The remaining ten classes were all located near universities with active interests in special education and, in several instances, in close proximity to special education Instructional Materials Centers. These locations, with two classrooms each, were: Eugene, Oregon; Salt Lake City, Utah; Las Vegas, Nevada; North Worchester County, Massachusetts; and Pinellas County, Florida.

The sixteen experimental classes, distributed across the United States, were located in pairs to reduce staff travel costs, and were generally near cooperative universities where preservice and inservice special education students could easily visit and they were located in different sized communities and within different areas of those communities.[7]

Control Classes

Control group classes were selected for geographic distribution and ease of arrangements. The schools conducting these classes agreed to adhere to a strict schedule for administering pretests and posttests. Control classes were located in Alton and Wood River, Illinois; Fort Worth, Texas; Pittsburgh and Huntington, Pennsylvania; Des Moines, Iowa; Clearwater and Tampa, Florida; Aurora, Arvada, and Wheat Ridge, Colorado; and Lancaster, California.[8]

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[7] See pages 14-19 for a description of the schools and student populations.

The Student Group in the Evaluation Study

Intermediate grade youngsters in special education classes are generally characterized as being 11- to 13-year-olds who have exhibited evidence of learning difficulties in regular school classes and who have scored from 50 to 80 on individually administered intelligence tests. Background data for classes using the BSCS *ME NOW* curriculum (experimental group) and for classes using their regular curriculum (control group) were gathered during the last week of October, 1970. One hundred and eighty students were enrolled in 16 experimental classes and 187 students enrolled in 16 control classes. Complete data--background, Unit I pretests scores and Unit I posttest scores, were secured for 166 (92%) of the experimental group. The remaining eight percent are not included due to the transferring out of the class or school while others failed to take either the pretest or posttest. Teachers administered both pretests and posttests to students who were absent from class on the day of testing if the student was available for testing within three or four days.

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[8] Ibid.

The experimental and control groups, described below, are the groups whose progress will be reported in each section of the report. Only when the groups for a particular unit of study differ markedly from the initial groups will further discussion be presented. This does not mean that exactly the same students are included in the student population for each unit of study.

The experimental group ranged in age from 78 to 193 months with a mean of 144.60 months, as shown in Table 3. A total of 21 students were older than 13 years and 12 were younger than 11. Only 2 students in the experimental group had measured IQ scores[9] of under 50, but 21 had scores above 80. The mean total IQ for the experimental group was 71.84.

Ethnically, 77.1 percent of the experimental group students were whites, 12.1 percent were blacks, and 10.8 percent were Spanish-Americans.

Teacher-rankings of reading achievement place 11.4 percent at the readiness level, 21.7 percent at first grade level, 28.9 percent at second grade level, 21.1 percent at third grade level, 12.7 percent at fourth grade level, and 4.2 percent at fifth grade level.[10]

Students also were ranked on a low to high scale of 1 to 5 according to the teachers' estimates of their verbal participation: non-verbal being ranked 1; average, 3; and very verbal, 5. Rankings were 7.8 percent, 1; 21.1 percent, 2; 28.3 percent, 3; 25.3 percent, 4; and 17.5 percent, 5.

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[9] WISC total IQ score.

[10] See Appendix 2 for instruction to teachers and the data form for securing background data.

Table 3. Unit I. Experimental Group, Student Background Information

	Age in Months							IQ (WISC)						Race[2]			Reading Achievement[3]						Verbal Participation[4]				
Teacher #	N	M	S	Range	Over 13 yrs	Under 11 yrs	σM	M	S	Range	σM	Over 80	Under 50	1	2	3	R	1	2	3	4	5	1	2	3	4	5
Form A[1]																											
21	5	136.80	9.42	126-149	0	0	4.21	65.40	9.56	54-80	4.27	0	0	3	2	0	1	2	1	1	0	0	0	1	4	0	0
22	13	127.46	8.13	113-140	0	5	2.56	74.15	7.63	62-84	2.11	3	0	6	3	4	0	3	7	3	0	0	0	8	3	2	0
23	12	140.33	12.07	121-162	0	2	3.48	73.58	10.72	51-88	3.10	2	0	12	0	0	0	3	1	1	6	1	0	0	8	1	3
24	10	133.90	7.96	120-143	0	2	2.52	69.20	9.84	54-83	3.11	1	0	7	1	2	3	3	4	0	0	0	1	1	0	5	3
25	11	148.18	14.99	120-167	2	1	4.52	78.00	12.38	62-96	3.73	5	0	11	0	0	3	3	2	1	1	1	3	3	2	1	2
26	10	141.80	6.56	132-152	0	0	2.08	76.90	8.80	64-91	2.78	3	0	2	8	0	0	1	6	2	1	0	1	6	1	2	0
27	10	137.80	25.31	78-170	2	1	8.00	72.30	7.36	57-81	2.33	1	0	10	0	0	1	1	1	1	3	3	1	1	2	2	4
28	8	153.88	9.40	136-166	1	0	3.32	73.13	8.08	60-84	2.86	2	0	8	0	0	0	3	4	1	0	0	0	0	2	4	2
All A	79	139.51	14.83	78-170	5	11	1.67	73.43	9.64	51-96	1.08	17	0	59	14	6	8	19	26	10	11	5	6	20	17	17	14
Form B[1]																											
31	6	151.33	8.21	138-159	0	0	3.35	69.67	13.56	52-87	5.54	1	0	6	0	0	1	2	2	0	1	0	1	1	2	2	0
32	11	131.55	9.21	112-145	0	1	2.78	69.82	7.88	49-77	2.38	0	1	11	0	0	7	2	2	0	0	0	1	0	4	6	0
33	10	162.60	16.08	144-186	4	0	5.09	69.00	7.15	55-76	2.26	0	0	10	0	0	0	0	2	8	0	0	3	1	5	1	0
34	10	166.50	14.68	146-193	5	0	4.64	72.20	5.90	64-81	1.87	1	0	7	0	3	1	0	6	2	1	0	0	0	7	2	1
35	10	142.40	6.50	133-154	0	0	2.06	66.60	8.71	51-76	2.75	0	0	4	6	0	0	6	0	4	0	0	0	3	1	3	3
36	11	164.36	10.19	146-175	7	0	3.07	72.73	3.10	69-79	0.94	0	0	11	0	0	0	1	2	2	5	1	1	3	1	1	5
37	15	139.93	6.85	132-156	0	0	1.77	74.13	7.36	59-85	1.90	1	0	15	0	0	0	4	3	7	1	0	0	2	4	8	1
38	14	143.21	6.78	134-153	0	0	1.81	67.71	10.96	44-82	2.93	1	1	5	0	9	2	2	5	2	2	1	1	5	6	2	0
All B	87	149.22	15.68	112-193	16	1	1.68	70.39	8.34	44-87	0.89	4	2	69	6	12	11	17	22	25	10	2	7	15	30	25	10
All	166	144.60	15.99	78-193	21	12	1.24	71.84	9.08	44-96	0.71	21	2	128	20	18	19	36	48	35	21	7	13	35	47	42	24
Boys	112	146.13	17.21	78-193	17	6	1.63	72.88	8.89	51-96	0.84	15	0	84	15	13	12	27	32	27	10	4	7	19	39	31	16
Girls	54	141.43	12.68	112-173	4	6	1.73	69.67	9.18	44-85	1.25	6	2	44	5	5	7	9	16	8	11	3	6	16	8	11	13

[1] Teachers are grouped by the pretest form to which they were assigned, i.e., Form A teachers administered Form A as a pretest and Form B as a postest.

[2] White = 1, Black = 2, Mexican-American = 3.

[3] R = Readiness, 1 = 1st grade, 2 = 2nd grade, 3 = 3rd grade, 4 = 4th grade, 5 = 5th grade.

[4] Continuum from 1 = Non Verbal to 5 = Very Verbal.

Four of the sixteen experimental classes were composed of students in urban, Title I target schools in Commerce City and Pueblo, Colorado; Salt Lake City, Utah; and Eugene, Oregon. Five classes were from low income, urban areas in Pinellas Park and St. Petersburg, Florida; Henderson, Nevada; Fitchburg, Massachusetts; and Des Moines, Iowa. Both Florida classes are located in special schools for handicapped children. Two classes were from low income, surburban areas in Eugene, Oregon and Des Moines, Iowa. Five classes were located in middle income surburban areas in Boulder and Littleton, Colorado; Salt Lake City, Utah; Lunenburg, Massachusetts; and Las Vegas, Nevada.

Background data, pretest and posttest scores of the control group were secured for 168 (90%) of the 187 students (see Table 4). The control group students were slightly older than the experimental group with a mean age of 147.85 months and an age range of 116 to 177 months. Twenty-one students were over 13 years old and 7 were under 11 years old. Fifteen students had measured IQ scores of over 80, one student had a score below 50, the mean total IQ was 70.20.

Ethnically, 77.4 percent of the control group students were whites, 19.6 percent were blacks, and 3.0 percent were Spanish-Americans.

Teacher rankings of reading achievement placed 9.5 percent of the control group at the readiness level, 24.4 percent at first grade level, 28.0 percent at second grade level, 17.9 percent at third grade level, 16.1 percent at fourth grade level, and 4.2 percent at fifth grade level.

Teachers' assessments of verbal participation, on a low to high scale of 1 to 5, placed 10.1 percent at level 1, 24.4 percent at level 2, 25.6 percent at level 3, 25.6 percent at level 4, and 14.3 percent at level 5.

Table 4. Unit I. Control Group, Student Background Information

	Age in Months							IQ (WISC)						Race[2]			Reading Achievement[3]						Verbal Participation[4]				
Teacher #	N	M	S	Range	Over 13 yrs	Under 11 yrs	σM	M	S	Range	σM	Over 80	Under 50	1	2	3	R	1	2	3	4	5	1	2	3	4	5
Form A[1]																											
81	11	137.55	10.35	119-151	0	1	3.12	66.91	4.59	60-76	1.38	0	0	11	0	0	1	3	7	0	0	0	0	2	3	6	0
82	7	169.86	5.87	164-177	7	0	2.22	70.14	3.48	66-74	1.32	0	0	7	0	0	1	0	2	1	2	1	1	1	1	1	3
83	11	141.55	17.20	120-168	2	2	5.19	74.73	8.96	60-94	2.70	2	0	11	0	0	1	5	1	2	2	0	0	2	2	4	3
84	12	134.25	7.15	119-144	0	2	2.06	71.08	5.58	59-78	1.61	0	0	7	5	0	1	4	3	4	0	0	1	8	3	0	0
85	8	153.63	6.48	142-161	0	0	2.29	80.25	8.17	67-94	2.89	4	0	4	4	0	0	4	4	0	0	0	0	1	4	3	0
86	9	159.22	11.16	136-173	3	0	3.72	68.56	7.70	55-79	2.57	0	0	4	5	0	0	0	6	2	1	0	2	4	2	1	0
87	11	145.18	3.25	142-153	0	0	0.98	78.18	5.60	67-86	1.69	3	0	11	0	0	0	0	1	3	5	2	0	3	3	5	0
88	11	141.27	5.55	133-148	0	0	1.67	71.40	6.82	61-80	2.16	0	0	10	1	0	1	3	3	3	1	0	1	3	4	3	0
All A	80	146.04	13.98	119-177	12	5	1.56	72.59	7.64	55-94	0.86	9	0	65	15	0	5	19	27	15	11	3	5	24	22	23	6
Form B[1]																											
91	12	161.92	9.47	148-175	6	0	2.73	61.08	7.89	51-74	2.28	0	0	11	1	0	1	3	2	2	3	1	0	1	1	6	4
92	9	157.22	6.14	150-172	1	0	2.05	74.44	6.19	65-83	2.06	2	0	9	0	0	0	0	2	1	6	0	0	1	2	4	2
93	12	138.42	12.01	116-159	0	2	3.46	66.18	5.79	58-74	1.75	0	0	6	3	3	3	5	3	1	0	0	2	4	6	0	0
94	9	145.22	10.83	134-168	1	0	3.61	63.75	7.34	49-72	2.60	0	1	7	0	2	2	4	2	0	1	0	1	3	3	0	2
95	7	145.14	10.43	133-162	0	0	3.94	72.43	10.13	59-82	3.83	3	0	7	0	0	2	0	1	2	1	1	0	0	0	4	3
96	10	147.10	10.78	129-159	0	0	3.41	73.89	4.17	68-81	1.39	1	0	10	0	0	0	3	3	3	1	0	0	0	3	3	4
97	14	152.00	7.74	141-162	0	0	2.07	67.29	5.06	59-75	1.35	0	0	0	14	0	0	2	6	0	4	2	1	6	1	3	3
98	15	147.67	8.00	132-164	1	0	2.06	68.20	6.41	57-77	1.65	0	0	15	0	0	3	5	1	6	0	0	8	2	5	0	0
All B	88	149.50	11.52	116-175	9	2	1.23	67.98	7.68	49-83	0.83	6	1	65	18	5	11	22	20	15	16	4	12	17	21	20	18
All	168	147.85	12.83	116-177	21	7	0.99	70.20	7.98	49-94	0.62	15	1	130	33	5	16	41	47	30	27	7	17	41	43	43	24
Boys	101	147.99	13.20	116-177	12	5	1.31	69.99	8.34	49-94	0.84	11	1	75	22	4	15	27	31	15	10	3	11	26	26	26	12
Girls	67	147.64	12.35	121-176	9	2	1.51	70.52	7.46	53-94	0.92	4	0	55	11	1	1	14	16	15	17	4	6	15	17	17	12

[1] Teachers are grouped by the pretest form to which they were assigned, i.e., Form A teachers administered Form A as a pretest and Form B as a postest.

[2] White = 1, Black = 2, Mexican-American = 3.

[3] R = Readiness, 1 = 1st grade, 2 = 2nd grade, 3 = 3rd grade, 4 = 4th grade, 5 = 5th grade.

[4] Continuum from 1 = Non Verbal to 5 = Very Verbal.

Of the sixteen control group classes, one class in Alton, Illinois was in a school classified as a Title I target school in an inner-city ghetto. Two classes were composed of low income, ghetto students from Fort Worth, Texas and Pittston, Pennsylvania. Five classes of students were from low income, urban areas in Des Moines, Iowa; Clearwater and Tampa, Florida; Forth Worth, Texas; and Security, Colorado. Both Florida classes were located in special schools for handicapped children. One class was from a low income, surburban area of Des Moines, Iowa. Four classes were from middle income, surburban areas of Aurora, Arvada (2), and Wheat Ridge, Colorado. Two classes were from middle income, urban areas of Wood River, Illinois and Lancaster, California. One class was from a middle income, rural area of Lancaster, California and one class was from a low income rural area of Huntington, Pennsylvania.

The data gathered support the interpretation that both the experimental and control groups were members of the population for whom the materials were designed. Limited financial support for evaluation did not permit random selections of either experimental or control groups and, therefore, nothing can be stated regarding the representativeness of either group in terms of the national 11- to 13-year old EMH population.

CHAPTER II

EVALUATION OF UNIT I

DIGESTION AND CIRCULATION

The Instructional Program

Instruction for all experimental classes with the revised edition of Unit I began in November, 1970. One class completed instruction before the Christmas holidays and the last class finished the unit the last week in February, 1971. The total time in class devoted to *ME NOW* during the period ranged from 865 to 3,055 minutes with a mean for the 16 classes of 1,228 minutes (20.5 hours).

The fate of food in "Me" and the distribution of digested food in "Me Now" is the focus of Unit I. The first activities in Unit I about food may be extremely easy for the student. This is by design. The ease with which the student is able to attain success will lead him, we hope, into an interest in science. A success syndrome may thus be established in a curriculum content area that has often been neglected in working with mentally handicapped children.

Food is tangible and concrete -- something we see and touch every day. Students are introduced to the fate of food by observing and tasting, and thereby identifying and describing characteristics of food before it enters the body. Associations with food needs are developed with student-focused activities. Relationships between food characteristics and the functions of the teeth, tongue, and mouth parts involve the students in an examination of chewing and swallowing.

The students develop ideas about the disappearance of food from the mouth and establish that there is a tube connecting the mouth to the stomach. They investigate stomach action by listening to stomach sounds and by manipulating a stomach model.

To answer the question of the fate of food in the body, the student must investigate not only the process of digestion, but also the processes of food distribution and utilization. The distributive function of blood circulation is examined next. Here again, the obvious and familiar external evidences of circulation -- heartbeat and pulse -- serve as the entrance point to instruction. The students infer associations between heart action and the resultant pulsing of blood as it circulates through the body. A simplified working model of the circulatory system is constructed by the students to illustrate additional functional relationships.

Finally, the process whereby digested food in the intestine passes through membranes into the blood is demonstrated. Through specifically designed activities, the students are able to observe the simulated movement of food in solution through a membrane, and to associate what they observe with what actually occurs in the body. The process of food utilization is studied later in Unit III.

It is especially important in this first unit to allow every student an opportunity to participate in the activities, for it is here that a high level of interest in scientific investigation may first be developed.

Effectiveness of Instruction: Data, Analysis, and Interpretation

The formative evaluation program was designed to secure answers to the questions proposed in Table 1. The conclusion reached and the judgments made in this section of the report are based on the ratings of the material by teachers participating in the program. This part of the report is organized according to the eight major objectives of Unit I. All of the data that relate to each objective are presented and interpreted within the discussion of the objective. These data and interpretations are then examined in relation to the questions proposed in classroom transactions and outcomes, as presented in Table 1.

Item analyses, using the FORTAP program,[11] were prepared for both experimental and control group pretests and posttests. Item data are presented immediately following the descriptive data under each objective.

Objective _100_. _Students_ _will_ _associate_ _foods_ _with_ _generalized_ _body_ _needs_. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective. As this was introductory to the *ME NOW* program, the developers assumed that many students would be able to perform the objective prior to instruction. The activities were designed to interest and motivate students and to provide them with success in their first experience with science learning.

For activities 1 to 3, 31 percent of the teachers reported that they used the prescribed strategies as described; 63 percent reported some modifications. All teachers reported that the strategies were successful. They suggested that the student worksheets for graphing height and weight, though revised as recommended after the 1970-71 testing, need further revision -- the height chart should be numbered in inches and the weight chart needs to go beyond 150 pounds and should be labeled with pounds and ounces.

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[11] Frank B. Baker and T. J. Martin. _Fortap_: _A_ _Fortran_ _Test_ _Analysis_ _Package_. Laboratory of Experimental Design, Wisconsin Research and Development Center for Cognitive Learning, The University of Wisconsin, March 1, 1968.

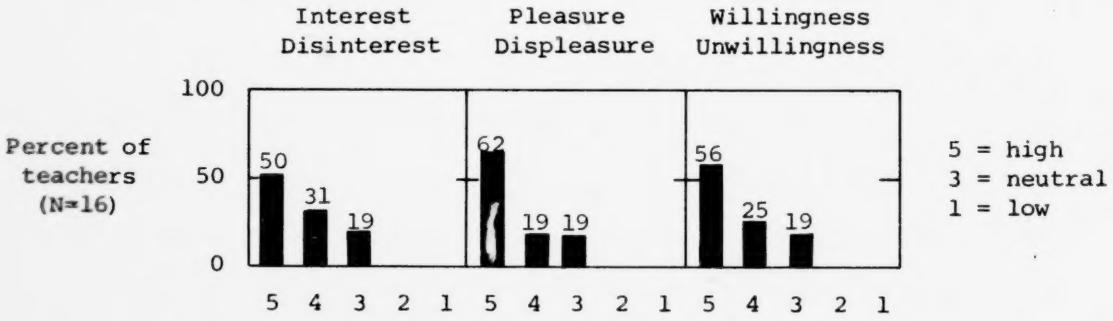

Figure 2. Reaction of the majority of students to activities 1 to 3

Figure 2 shows that teachers found student reactions to be markedly high across three rating scales.[12] Activities 1 and 2 were considered to be more important than activity 3, but the general judgment expressed was that the activities as a group were important (see Figure 3).

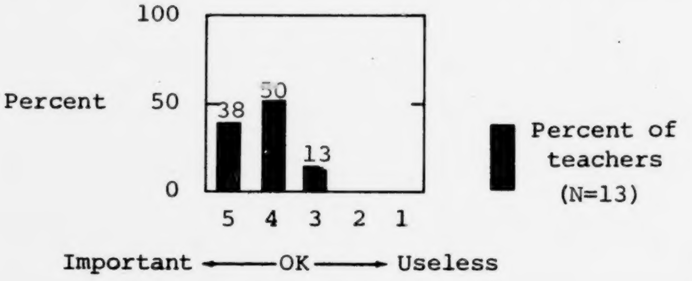

Figure 3. Importance to students of activities 1 to 3

Student performance with respect to objective 100 was assessed by items on the pretest and posttest and by teacher ratings of student performance and the importance of the subobjectives of objective 100.[14]

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[12] See Appendix II for a copy of the Teacher Feedback Questionnaire.

[13] The number of the experimental teachers (N=16) rating each of the eight subobjectives ranged from 14 to 16. The total percent may exceed or be less than 100 percent due to rounding error.

[14] See Appendix III for a list of objectives and subobjectives.

Figure 4 shows the proportions of students in the class who were able to perform the behaviors specified by the eight subobjectives. Teachers considered the subobjectives for this activity important (Figure 5) and indicated that most students performed the specified behaviors during instruction.

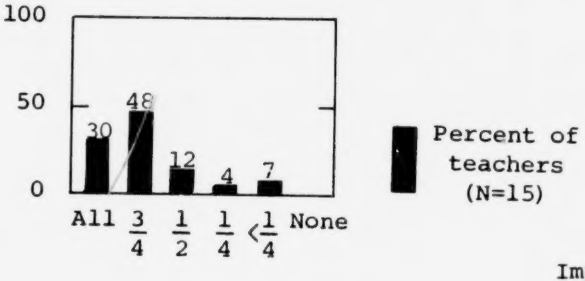


Figure 4. Proportion of students able to perform on subobjectives of objective 100

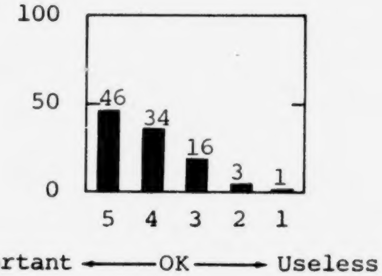
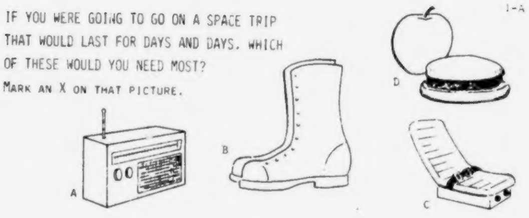
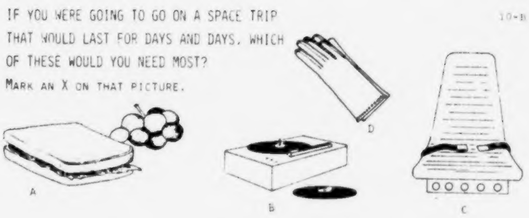


Figure 5. Importance of the subobjectives

Four item pairs were designed to sample achievement on this objective.


IF YOU WERE GOING TO GO ON A SPACE TRIP THAT WOULD LAST FOR DAYS AND DAYS, WHICH OF THESE WOULD YOU NEED MOST? MARK AN X ON THAT PICTURE.


IF YOU WERE GOING TO GO ON A SPACE TRIP THAT WOULD LAST FOR DAYS AND DAYS, WHICH OF THESE WOULD YOU NEED MOST? MARK AN X ON THAT PICTURE.

Gains were made by both the experimental and control groups on item pair 1-A, 10-B which was judged to function at the cognitive level of knowledge (see Table 6). The gain for the control group can be accounted for by a shift, in Form A, from selecting boots, and by a shift, in Form B, from selecting music. The gloves in item 10-B registered a slight gain. The biserial correlations showed significant

Table 6. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M*	O*	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-1	79	20	5	41	33	1	0	87	1	9	43	47	0	0	.13	.32
	B-10	87	47	3	5	45	0	0	79	62	0	1	37	0	0	.31	.65
Control	A-1	80	10	11	31	48	0	0	88	2	8	25	65	0	0	.57	.37
	B-10	88	73	1	0	26	0	0	80	63	1	1	35	0	0	.62	.40

*M represents multiple responses that included the correct response; O represents omissions; underlined percentages indicate correct response.

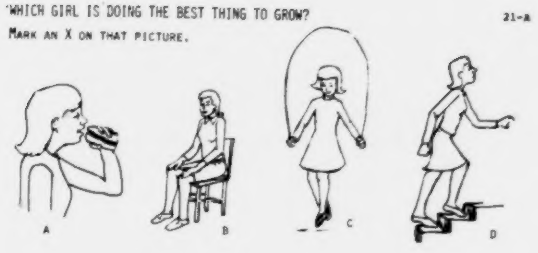
Table 7. Pretest to Posttest Changes*
(The response choice for A-1 is cited first.)

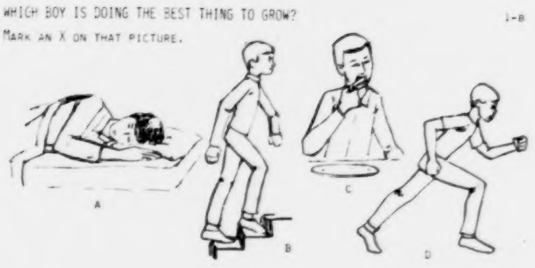
Item Pair A-1, B-10	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	B	A+B	B	D	B+D	C	C	C+C
Experi-mental	+14	+15	+14	-19	-3	-10	+4	-8	-4	+2	-4	0
Control	+17	-10	+3	-8	0	-3	-3	+9	+2	-6	+1	-1

*This table will be included for every item pair and should be read as, for example, 14 percent more of the experimental group selected response D in item A-1 on the posttest as compared to the pretest.

improvement from pretest to posttest in the experimental group. After instruction, 43 percent of the experimental group students selected response C, the chair, in Form A and 37 percent selected response D, the gloves, in Form B. The small control group gain can be attributed to a loss in selecting music on the posttest.

The artwork on item response C, Form A, should be revised to appear more like the chair in Form B. Also, the gloves in item response D, Form B, should be modified to look more like space gloves. Teachers suggested that the hamburger, choice D in item 1-A, could be improved.


WHICH GIRL IS DOING THE BEST THING TO GROW?
MARK AN X ON THAT PICTURE.
A
B
C
D
21-A


WHICH BOY IS DOING THE BEST THING TO GROW?
MARK AN X ON THAT PICTURE.
A
B
C
D
1-B

Item pair 21-A, 1-B was judged to function at the cognitive level of knowledge and to provide data to be grouped with baseline items to provide a profile of entry-level behaviors for a class group. Baseline data items are considered to be useful for establishing a point of reference for individuals and groups but to be of less value in providing information on the achievement of students as a result of the instruction program.

Although a net gain of four percent (see Table 9) was achieved by the experimental group, some confusion was evident within forms. There was a loss of 12 percent on Form A, which can be attributed to a shift to response C, heavy exercise. On Form B there was a gain of 20 percent, which can be accounted for by a shift from choice D, heavy exercise. Rest (choice A) was also a strong distractor in Form B. The same general response pattern exists for the control group, although the posttest biserial correlation was positive and higher for the 21-A, 1-B control group than for the similar experimental group.

These data on the item pairs seem to indicate that there was some difficulty on the part of the EMH students in distinguishing which is

Table 8. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-21	79	78	3	16	3	0	0	87	66	3	26	4	0	0	.47	-.02
	B-1	87	20	0	51	29	1	0	79	18	0	71	10	0	0	.02	.34
Control	A-21	80	69	3	29	0	0	0	88	72	2	23	2	1	0	.29	.34
	B-1	88	31	1	59	8	1	0	80	21	1	63	14	1	0	.24	.39

Table 9. Pretest to Posttest Changes
(The response choice for A-21 is cited first.)

Item Pair A-21, B-1	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	A	B+A	C	B	C+B	D	D	D+D
Experi-mental	-12	+20	+4	0	-2	-2	+10	0	+6	+1	-19	-10
Control	+3	+4	+4	-1	-10	-7	-6	0	-1	+2	+6	+4

most important -- food, rest or exercise. A probable explanation is that health and physical education teachers have been stressing the importance of rest and exercise and the *ME NOW* materials are simply adding one more item to the list of important things to do. It may be that the EMH student is not capable of making these rank order distinctions, although gains of 14 and 12 percent, respectively, were made on the identical items in the previous evaluation study.[15]

We recommend that this item be left in the test to help teachers identify students who have not been able to rank order the importance of food, rest and exercise in relation to growth needs. The problems of teaching for these distinctions should be pointed out in the revised Teacher's Guide.

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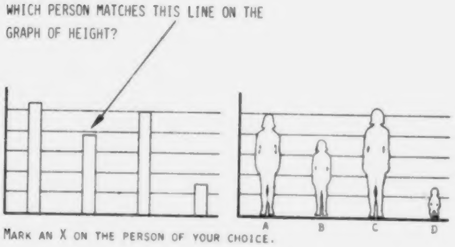
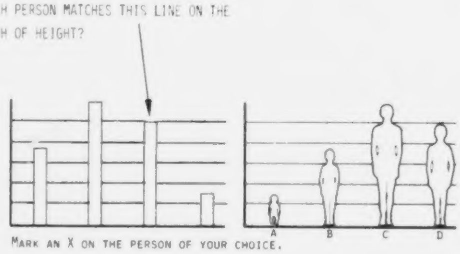
[15] James T. Robinson and Richard R. Tolman. A Formative Evaluation of *ME NOW*, Unit I, Digestion and Circulation. Boulder, Colorado: Biological Sciences Curriculum Study, University of Colorado, September, 1970, p. 42.

Item pair 4-A, 5-B was judged to provide baseline data and to function at the cognitive level of comprehension. Table 10 indicates that both experimental and control classes made gains on this item pair, and biserial correlations indicate that this pair of items is discriminating well between students who achieved a high score on the test and students who achieved low scores. Teachers suggested that the stem be changed to read, "Which person is as tall as this line on the graph of height?" The second and third bars in the height graph on Form A should be transposed to avoid giving position as a clue to the correct response.


4-A

WHICH PERSON MATCHES THIS LINE ON THE GRAPH OF HEIGHT?

MARK AN X ON THE PERSON OF YOUR CHOICE.


5-B

WHICH PERSON MATCHES THIS LINE ON THE GRAPH OF HEIGHT?

MARK AN X ON THE PERSON OF YOUR CHOICE.

Table 10. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-4	79	13	77	4	1	5	0	87	13	80	3	0	3	0	.62	.64
	B-5	87	1	3	11	83	1	0	79	0	2	11	84	3	0	.63	.81
Control	A-4	80	11	69	10	1	8	1	88	7	81	6	1	6	0	.39	.67
	B-5	88	1	1	15	75	8	0	80	1	0	9	88	3	0	.31	.62

Table 11. Pretest to Posttest Changes
(The response choice for A-4 is cited first.)

Item Pair A-4, B-5	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	D	B+D	A	B	A+B	C	C	C+C	D	A	D+A
Experimental	+3	+1	+2	0	-1	0	-1	0	-1	-1	-1	-1
Control	+12	+13	+12	-4	-1	-2	-4	-6	-6	0	0	0

This item pair and the next item pair to be discussed (12-A, 20-B) were included to determine whether students could interpret graphical data. Students seem to have difficulty with graphing activities.[16] At the briefing session, experimental group teachers felt that students would not be able to respond to these items. The high initial success of students on these items (see Tables 10 and 12) provides evidence for the necessity to empirically verify such judgments. Lack of knowledge of instruction in the control classes makes an explanation of the marked gains on this item pair impossible. Instruction in the graphing activities did not change posttest results in the experimental group (see Table 11).

Item pair 12-A, 20-B was judged to provide baseline data and to function at the cognitive level of comprehension. Data from this and the previous item pair clearly indicate that students in the experimental and control groups can successfully transfer data presented in graph form to figures, and vice versa, before instruction.

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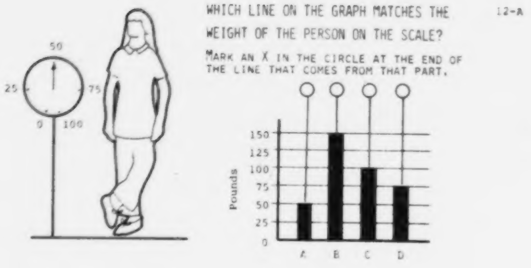
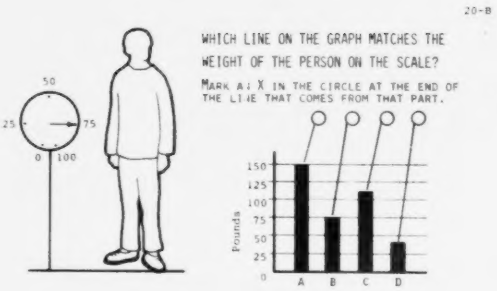
[16] See Robinson and Tolman, p. 78.


12-A

WHICH LINE ON THE GRAPH MATCHES THE WEIGHT OF THE PERSON ON THE SCALE?

MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT COMES FROM THAT PART.


20-B

WHICH LINE ON THE GRAPH MATCHES THE WEIGHT OF THE PERSON ON THE SCALE?

MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT COMES FROM THAT PART.

Table 12. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-12	79	72	15	1	4	8	0	87	77	16	4	0	2	0	.59	.28
	B-20	87	21	63	6	5	3	2	79	13	72	8	3	4	0	.56	.65
Control	A-12	80	66	10	4	11	8	1	88	84	7	1	6	2	0	.61	.70
	B-20	88	19	70	3	5	2	0	80	14	74	4	3	5	1	.53	.38

Teachers requested that this stem be changed to read, "Which line on the graph is the same as the weight of the person on the scale?" They also suggested that instructions in all items of this type be changed to read, "Mark an X on the line that touches that part." This seems much clearer and avoids lengthy sentences that may be confusing to the EMH student. Since control group gains were greater than those of the experimental group, gains cannot be attributed to the effect of instruction. The biserial correlations were high for both the experimental and control groups.

The initial success of students with the two item pairs on graph reading indicates that graphical communication can be used in instruction when such communication would be useful.

Table 13. Pretest to Posttest Changes
(The response choice for A-12 is cited first.)

Item Pair A-12, B-20	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	B	A+B	B	A	B+A	C	C	C+C	D	D	D+D
Experimental	+5	+9	+8	+1	-8	-3	+3	+2	+2	-4	-2	-4
Control	+18	+4	+11	-3	-5	-5	-3	+1	-1	-5	-2	-3

Objective 101. Students will associate food types with plant and animal sources. Four student activities and other instructional strategies were designed to develop student competencies to achieve this objective. Similar to objective 100, the developers assumed that some students would be familiar with the content of this objective prior to instruction.

Fifty-six percent of the teachers reported that they used the prescribed strategies as described; 44 percent reported some modifications. All teachers reported that the strategies were successful. No problems with materials were encountered, although many students initially

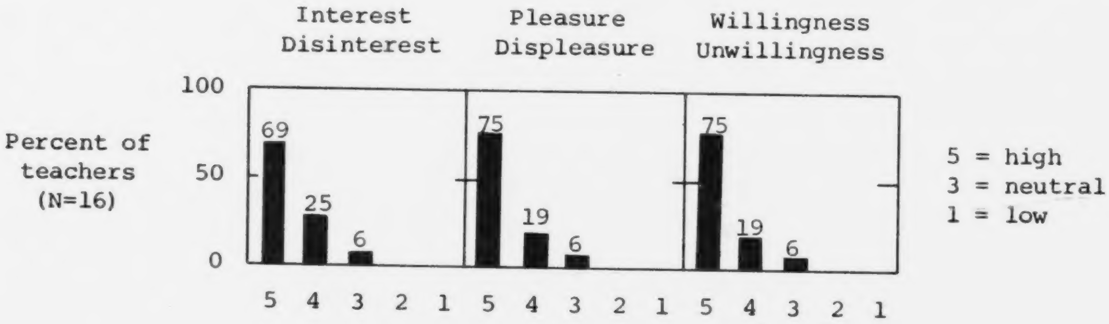


Figure 6. Reaction of the majority of students to activities 4 to 7

thought that the food items came from the store; they did not associate food with plants or animals.

Figure 6 shows that student reactions were very high across the three rating scales. Activities 5, 6 and 7 were more important than activity 4, but (see Figure 7), all activities were considered important for EMH children. Eighty-one percent of the teachers estimated that three-fourths or more of their students were able to perform the behaviors specified by the subobjectives and they judged the subobjectives to be very important (Figures 8 and 9).

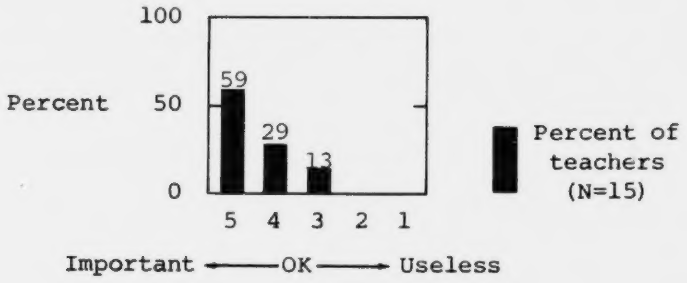


Figure 7. Importance to students of activities 4 to 7

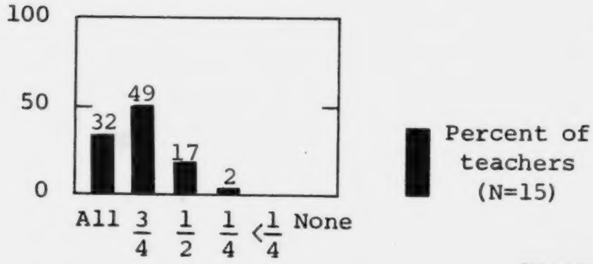


Figure 8. Proportion of students able to perform on subobjectives of objective 101

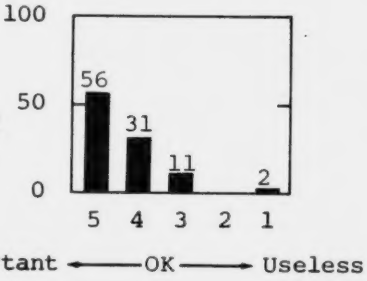
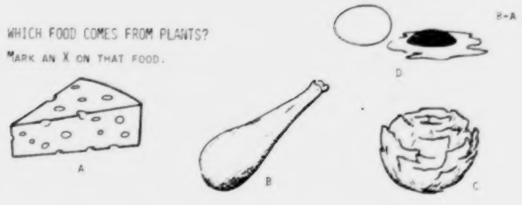
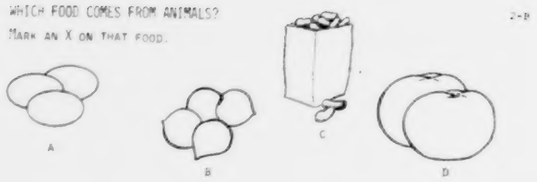


Figure 9. Importance of the subobjectives

Two item pairs were designed to sample achievement on this objective.


WHICH FOOD COMES FROM PLANTS?
MARK AN X ON THAT FOOD.
A
B
C
D
8-A


WHICH FOOD COMES FROM ANIMALS?
MARK AN X ON THAT FOOD.
A
B
C
D
2-B

Item pair 8-A, 2-B was judged to provide baseline data for this objective and to function at the cognitive level of knowledge. Item 8-A required the selection of one animal-source food from three plant-source foods, and item 2-B required the selection of one plant-source food from three animal-source foods. Although a high success rate (91 percent) was achieved on the pretest by the experimental group, gains were still recorded on the posttest (97 percent). The biserial correlations remain very high despite the high success rate. Since control group gains were also high (from 91 to 98 percent) we cannot conclude that experimental group gains on this item pair were attributable to the effect of instruction.

Table 14. Item Responses and Biserial Correlations for Experimental and Control Groups

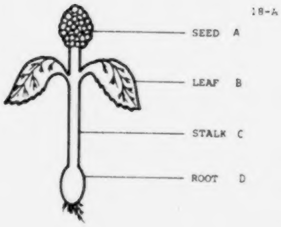
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-8	79	0	2	96	1	0	0	87	1	0	99	0	0	0	.59	.51
	B-2	87	87	6	6	1	0	0	79	95	1	4	0	0	0	.49	.67
Control	A-8	80	0	6	91	3	0	0	88	0	1	97	1	1	0	.49	.47
	B-2	88	91	3	3	2	0	0	80	98	0	3	0	0	0	.49	.57

Table 15. Pretest to Posttest Changes
(The response choice for A-8 is cited first.)

Item Pair A-8, B-2	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	B	A+B	B	C	B+C	D	D	D+D
Experi-mental	+3	+8	+6	+1	-5	-2	-2	-2	-2	-1	-1	-1
Control	+6	+7	+6	0	-3	-2	-5	0	-2	-2	-2	-1

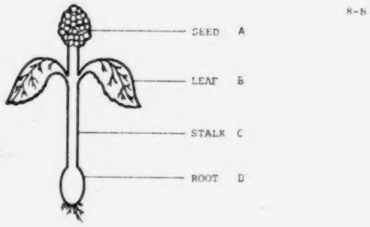
A BEAN COMES FROM
WHAT PART OF A PLANT?

MARK AN X ON THE LINE
THAT TOUCHES THAT PART.



A RADISH COMES FROM
WHAT PART OF A PLANT?

MARK AN X ON THE LINE
THAT TOUCHES THAT PART.



Item pair 18-A, 8-B provides baseline data for this objective and functions at the cognitive level of comprehension. A net loss of three percent was achieved across forms in the experimental group. Although the stylized plant illustration was used in instruction, it is possible that some students may not be familiar with beans and radishes. The more general explanation would be that EMH students may not be able to associate vegetables not used in instruction with the parts of the stylized plant. This item pair could be revised to include vegetables used during instruction, though this would reduce the cognitive level to recall. On the other hand, the biserial correlations are very good, indicating one other possibility -- that the students who scored low on the test are having difficulty associating vegetables not used in instruction with the parts of the stylized plant and that higher scoring students can make this association. Instructions on how to involve slower students could remedy this problem. Teachers should be encouraged to plant seeds and grow the plants in the classroom so that students can see the edible portions in relation to the whole plant. Also, wherever possible, entire plants should be purchased and brought into the classroom instead of merely the edible portions. The revised edition of the Teacher's Guide contains a suggested field trip to the supermarket.

Table 16. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-18	79	70	6	0	24	0	0	87	62	2	8	28	0	0	.53	.53
	B-8	87	28	8	3	60	1	0	79	22	11	5	62	0	0	.34	.54
Control	A-18	80	51	6	1	41	0	0	88	42	7	1	49	1	0	.25	.29
	B-8	88	23	2	3	69	2	0	80	40	6	0	54	0	0	.23	-.09

Table 17. Pretest to Posttest Changes
(The response choice for A-18 is cited first.)

Item Pair A-18, B-8	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	D	A+D	B	B	B+B	C	C	C+C	D	A	D+A
Experi-mental	-8	+2	-3	-4	+3	-1	+8	+2	+6	+4	-6	-1
Control	-9	-15	-12	+1	+4	+3	0	-3	-1	+8	+17	+13

Objective 102. Students will distinguish differences in physical characteristics of foods. Two student activities were designed to develop student competencies to achieve this objective.

Fifty-six percent of the teachers reported that they used the prescribed strategies; 44 percent reported some modifications. All teachers reported that the strategies were successful. One teacher's comment was very noteworthy -- "I will admit I thought the wording and strategies were poor on this unit, until I tried it. I used them exactly, though, and they were highly successful." One teacher indicated that the pliers-type juicer was difficult to locate, and several teachers noted a reluctance on the part of some students to taste baby food.

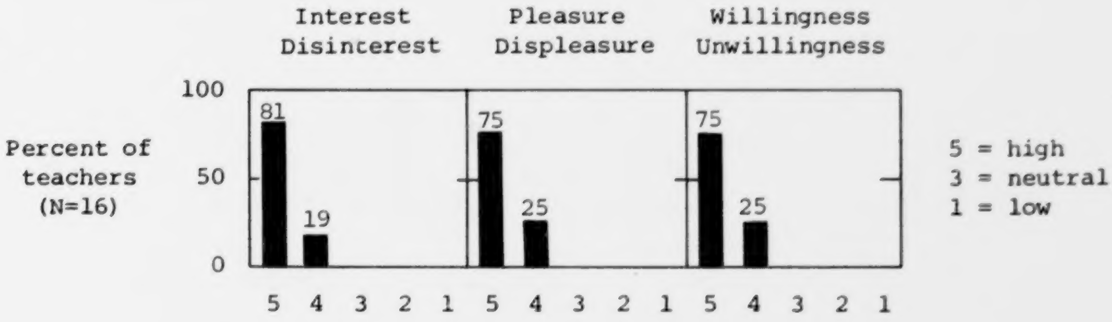


Figure 10. Reaction of the majority of students to activities 8 and 9

Figure 10 shows that student reactions were very high across the three rating scales. Both activities are important for EMH children (Figure 11).

Figure 12 shows the proportion of students who were able to perform the behaviors specified by the one subobjective of objective 102. Sixty-one percent of the teachers indicated that three-fourths or more of their students were able to perform these behaviors. Ninety-one percent indicated that over half had performed successfully.

Student success in the activities of objective 102 was moderately high. This was measured by teacher judgment, no test items were used. The subobjective was also rated as very important by the teachers (see Figure 13).

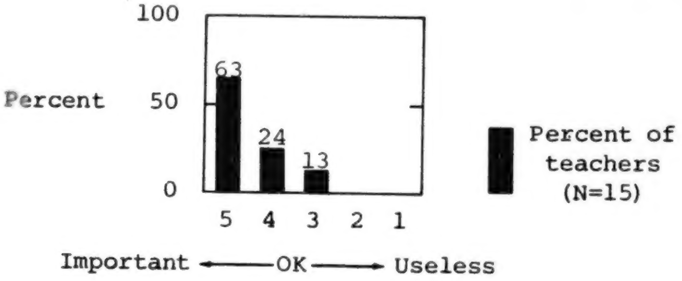


Figure 11. Importance to students of activities 8 and 9

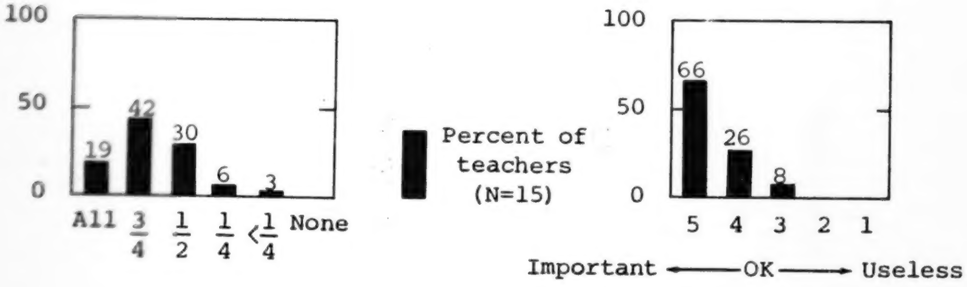


Figure 12. Proportion of students able to perform on the subobjective of objective 102

Figure 13. Importance of the subobjective

Objective 103. Students will relate structure with function of mouth parts. Six student activities and other instructional strategies were designed to develop student competencies to achieve this objective. The writers assumed that the students would not be familiar with the subject matter under this and subsequent objectives.

Sixty-three percent of the teachers used the strategies as described;

37 percent reported some modification. All teachers reported that the strategies were successful and no problems with materials were encountered. Many of the students knew some of the functions of the teeth and tongue, but not all. No students were familiar with the role of saliva in swallowing and digestion.

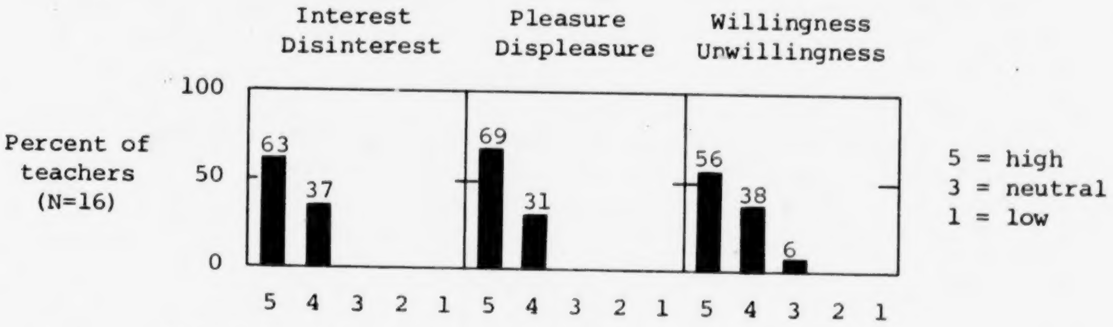


Figure 14. Reaction of the majority of students to activities 10 to 15

Figure 14 shows that student reactions were very high across the three rating scales. All activities were judged to be important, with activity 11 (Function of the Tongue) judged most important for EMH children (see Figure 15).

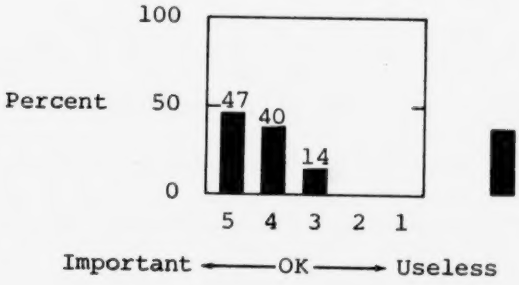


Figure 15. Importance to students of activities 10 to 15

Figure 16 shows the proportion of students who were able to perform the behaviors specified by the four subobjectives of objective 103. Seventy-one percent of the teachers estimated that three-fourths or more of their students were able to perform the behaviors.

They felt these subobjectives were very important (Figure 17).

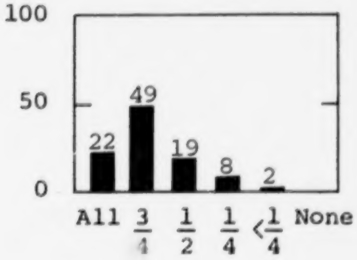


Figure 16. Proportion of students able to perform on subobjectives of objective 103

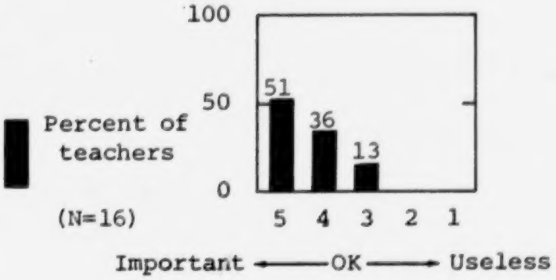
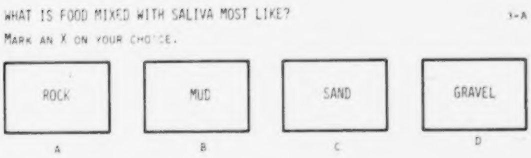


Figure 17. Importance of the subobjectives

Five item pairs were designed to sample achievement on this objective.

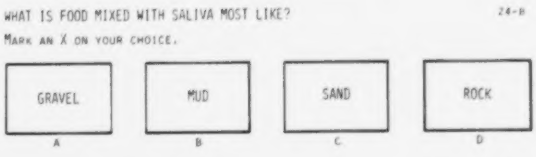


3-A

WHAT IS FOOD MIXED WITH SALIVA MOST LIKE?

MARK AN X ON YOUR CHOICE.

ROCK	MUD	SAND	GRAVEL
A	B	C	D



24-B

WHAT IS FOOD MIXED WITH SALIVA MOST LIKE?

MARK AN X ON YOUR CHOICE.

GRAVEL	MUD	SAND	ROCK
A	B	C	D

Item pair 3-A, 24-B functions at the cognitive level of analysis and was designed to determine if students could compare food-saliva mixtures with other materials of similar consistency. A net gain of 27 percent was achieved across both Forms A and B in the experimental group, indicating that significant learning occurred during instruction. The biserial correlation increased from pretest to posttest for Form B, but decreased for Form A. However, .28 for Form A is still acceptable and indicates a good discriminating item.

Teachers were nearly unanimous in wanting to include the four response choices in the stem of the item because some students could not read the words. In the future, all response choices should be included in the stem and read to the class.

Table 18. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-3	79	9	24	33	34	0	0	87	1	43	30	26	0	0	.56	.28
	B-24	87	32	29	29	8	1	1	79	14	67	14	4	1	0	.40	.60
Control	A-3	80	10	26	30	31	3	0	88	2	32	31	35	0	0	.61	.46
	B-24	88	25	35	30	9	1	0	80	18	48	24	10	1	0	.42	.42

Table 19. Pretest to Posttest Changes (The response choice for A-3 is cited first.)

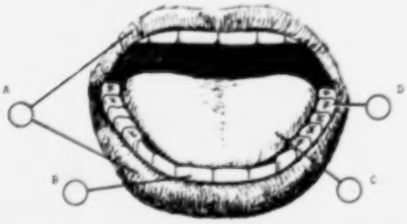
Item Pair A-3, B-24	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	D	A+D	C	C	C+C	D	A	D+A
Experi-mental	+19	+38	+27	-8	-4	-6	-3	-15	-9	-8	-18	-13
Control	+6	+13	+9	-8	+1	-3	+1	-6	-2	+4	-7	-1

Item pair 5-A, 7-B provides baseline information for this objective

WHAT PART IS BEST FOR GRINDING (CHEWING) FOOD INTO LITTLE PIECES?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.

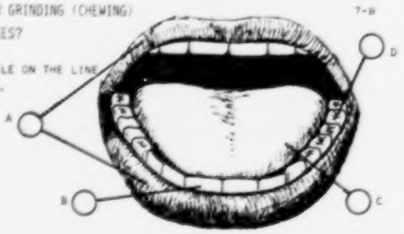
5-A



WHAT PART IS BEST FOR GRINDING (CHEWING) FOOD INTO LITTLE PIECES?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.

7-B



and functions at the cognitive level of knowledge. Both experimental and control groups showed net gains from pretest to posttest. The net change of 17 percent across forms in the experimental group clearly shows that learning is taking place as a result of instruction. The biserial correlations on the posttest (.56 and .91 for Forms A and B, respectively) indicate that this pair of items is functioning well in discriminating between students with low and those with high posttest scores.

Table 20. Item Responses and Biserial Correlations
for Experimental and Control Groups

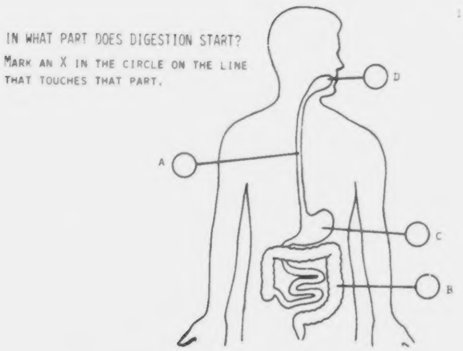
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-5	79	1	22	4	72	0	1	87	3	7	3	86	0	0	.32	.56
	B-7	87	3	20	7	69	1	0	79	0	6	5	89	0	0	.52	.91
Control	A-5	80	3	25	1	71	0	0	88	2	15	8	75	0	0	.43	.46
	B-7	88	2	16	5	75	2	0	80	0	14	8	79	0	0	.46	.09

Table 21. Pretest to Posttest Changes
(The response choice for A-5 is cited first.)

Item Pair A-5, B-7	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	B	B+B	C	C	C+C
Experi-mental	+14	+20	+17	+2	-3	0	-15	-14	-14	-1	-2	-2
Control	+4	+4	+4	-1	-2	-1	-10	-2	-5	+7	+3	+5

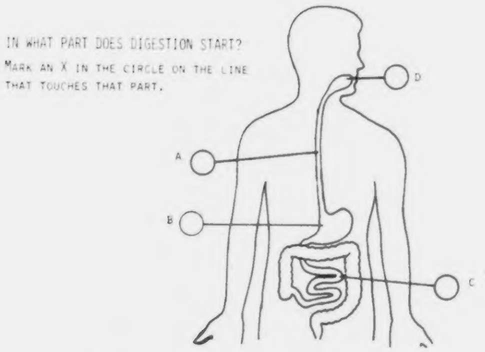
Item pair 13-A, 4-B functions at the cognitive level of knowledge. This item pair showed a significant improvement in student gain from pretest to posttest for the experimental group, but there was a net

13-A



IN WHAT PART DOES DIGESTION START?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

4-B



IN WHAT PART DOES DIGESTION START?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

loss on this item pair for the control group. The gain of 21 percent in the experimental group can be attributed to a response shift from the intestine to the correct choice, the mouth. However, Table 22 shows that 26 percent of the experimental group still chose the stomach after instruction. The actual beginning point of digestion should receive more emphasis in the instructional materials. The biserial

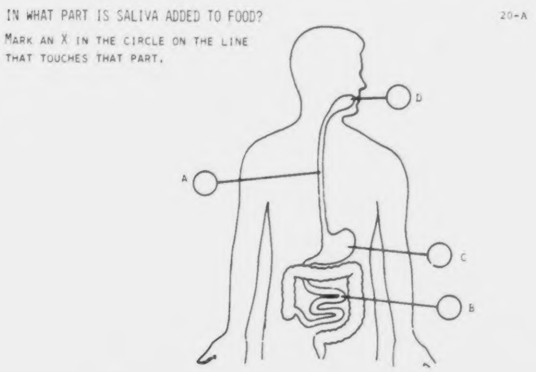
Table 22. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-13 B-4	79 87	18 8	25 20	29 38	28 32	0 1	0 0	87 79	17 3	7 23	29 19	47 56	0 0	0 0	.21 .03	.24 .48
Control	A-13 B-4	80 88	10 3	23 38	34 34	33 25	1 0	0 0	88 80	14 5	26 40	38 24	22 31	1 0	0 0	.46 .21	.01 .57

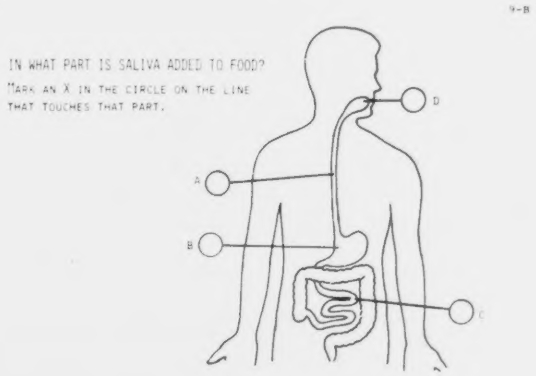
Table 23. Pretest to Posttest Changes (The response choice for A-13 is cited first.)

Item Pair A-13, B-4	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	C	B+C	C	B	C+B
Experi-mental	+19	+24	+21	-1	-5	-3	-18	-19	-19	0	+3	+2
Control	-11	+6	-3	+4	+2	+4	+3	-10	-4	+4	+2	+3

correlations for Forms A and B of .24 and .48, respectively, indicate that the items are good discriminators.


IN WHAT PART IS SALIVA ADDED TO FOOD?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

20-A


9-B

IN WHAT PART IS SALIVA ADDED TO FOOD?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

A mean gain of 37 percent from pretest to posttest was achieved by the experimental group on item pair 20-A, 9-B. This result can be accounted for by shifts from all three distractor pairs. The control group registered no gains on this item pair. The cognitive level of this pair of items is knowledge, and, based on an experimental-control group comparison, it is evident that substantial student gains were made in the experimental group as a result of instruction (see Table 25).

Table 24. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-20	79	14	37	18	32	0	0	87	7	7	16	70	0	0	.41	.81
	B-9	87	5	23	31	40	1	0	79	8	10	3	77	0	0	.42	.59
Control	A-20	80	11	31	28	30	0	0	88	23	26	20	30	0	0	.67	.61
	B-9	88	8	20	36	35	0	0	80	10	21	34	35	0	0	.20	.57

Table 25. Pretest to Posttest Changes
(The response choice for A-20 is cited first.)

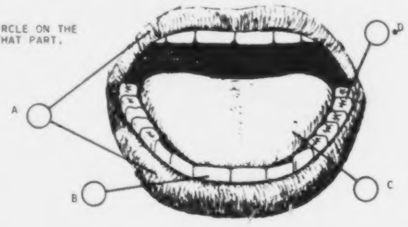
Item Pair A-20, B-9	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	C	B+C	C	B	C+B
Experi-mental	+38	+37	+37	-7	+3	-2	-30	-28	-29	-2	-13	-8
Control	0	0	0	+12	+2	+8	-5	-2	-4	-8	+1	-4

Item pair 24-A, 17-B provides baseline information on this objective and functions at the cognitive level of knowledge. Although pretest means were high for this item pair, a mean gain of 11 percent (80 to 91 percent) was achieved by the experimental group. Interestingly, a comparison of this item pair with 5-A, 7-B would indicate that students were initially more knowledgeable about the function of the teeth than that of the tongue. Here again, this probably reflects the emphasis given to oral hygiene in most EMH classes. A mean gain of two percent (from 85 to 87 percent) was achieved by the control group. Although pretest means for the control group were higher than for the experimental group, the pretest to posttest mean gain was much higher for the experimental group than for the control group, indicating that instruction did have an effect in the experimental group.

WHAT PART PUSHES FOOD AROUND
IN THE MOUTH?

MARK AN X IN THE CIRCLE ON THE
LINE THAT TOUCHES THAT PART.

24-A



WHAT PART MOVES FOOD AROUND
IN THE MOUTH?

MARK AN X IN THE CIRCLE ON THE
LINE THAT TOUCHES THAT PART.

17-B

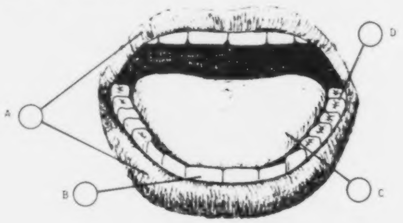


Table 26. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-24	79	8	3	89	1	0	0	87	0	6	91	3	0	0	.09	.96
	B-17	87	8	6	72	13	1	0	79	4	1	91	4	0	0	.69	.77
Control	A-24	80	8	3	84	5	1	0	88	6	2	85	6	1	0	.65	.78
	B-17	88	5	5	85	5	0	1	80	1	4	90	5	0	0	.44	.50

Table 27. Pretest to Posttest Changes (The response choice for A-24 is cited first.)

Item Pair A-24, B-17	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experimental	+2	+19	+11	-8	-4	-6	+3	-5	-1	+2	-9	-4
Control	+1	+5	+2	-2	-4	-2	-1	-1	-1	+1	0	+1

Objective 104. Students will relate location with structure and function of the esophagus. Two student activities and other instructional strategies were designed to develop student competencies to achieve this objective. The writers assumed that very few students would be familiar with the content of this objective prior to instruction.

Seventy-five percent of the teachers used the strategies as described; 25 percent reported some modification. All reported that the strategies were successful. Some difficulties were encountered with the X-ray film that depicts chewing and swallowing, but this was expected since the film was not designed for use with this program.

A new series of films specifically for use with *ME NOW* will eliminate the problems encountered with substitute films during experimental trials.

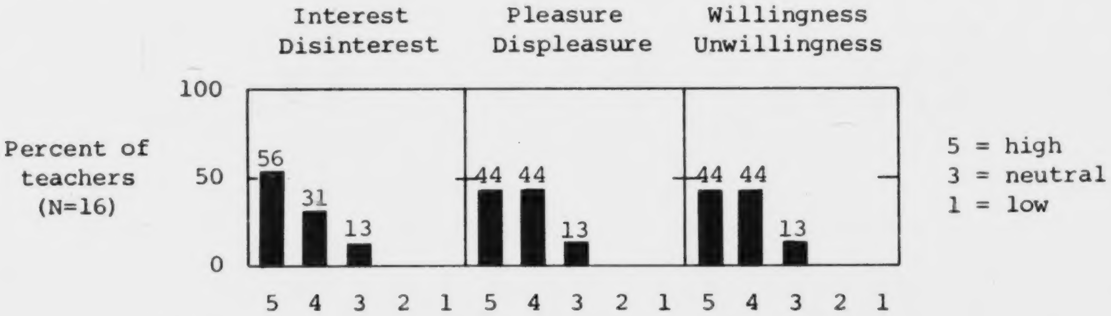


Figure 18. Reaction of the majority of students to activities 16 and 17

Figure 18 shows that student reactions were high across the three rating scales, although not as high as for previous activities. Figure 19 shows that both activities were judged important for EMH students.

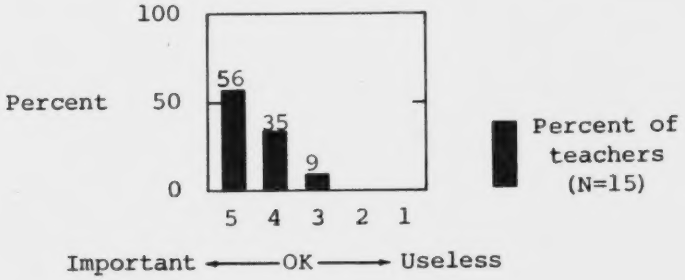


Figure 19. Importance to students of activities 16 and 17

Figure 20 shows the proportion of students who were able to perform the behaviors specified by the two subobjectives of objective 104. Seventy-one percent of the teachers estimated that three-fourths or more of their students were able to perform these behaviors. Although this percentage is identical to that for objective 103, more teachers (40 percent) indicated that all of their students could successfully

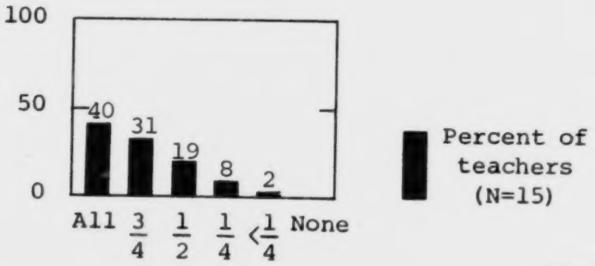


Figure 20. Proportion of students able to perform on subobjectives of objective 104

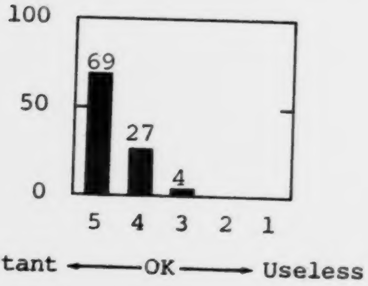
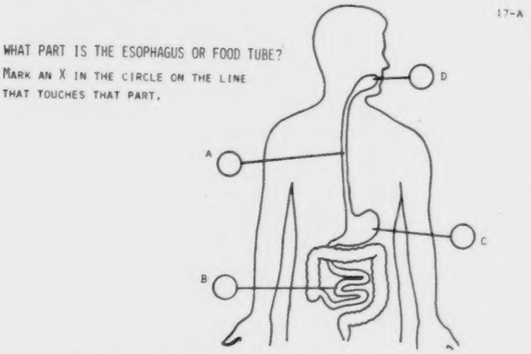


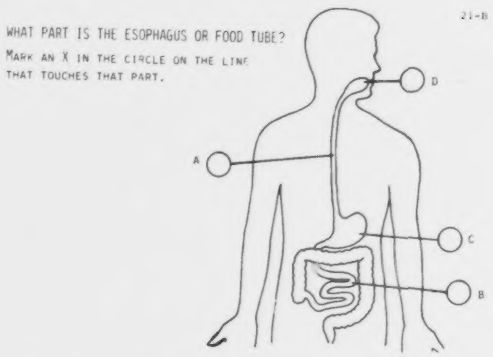
Figure 21. Importance of the subobjectives

perform the desired behaviors. Figure 21 shows that teachers judged the subobjectives to be important.

One pair of test items was designed to sample achievement on this objective.



WHAT PART IS THE ESOPHAGUS OR FOOD TUBE?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHAT PART IS THE ESOPHAGUS OR FOOD TUBE?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

Item pair 17-A, 21-B functions at the cognitive level of knowledge. A mean gain of 48 percent from pretest to posttest was achieved by the experimental group. There was no mean gain for the control group, indicating that the large experimental group gain can be attributed to instruction. The gain can be accounted for by losses in all three distractor response pairs. The biserial correlations indicate that the items are good discriminators.

Table 28. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-17	79	30	39	23	6	1	0	87	79	14	5	2	0	0	.54	.68
	B-21	87	40	23	29	8	0	0	79	87	6	3	4	0	0	.50	.48
Control	A-17	80	34	33	20	14	0	0	88	26	44	23	5	2	0	.29	.29
	B-21	88	30	36	22	10	2	0	80	39	31	23	8	0	0	.50	.29

Table 29. Pretest to Posttest Changes
(The response choice for A-17 is cited first.)

Item Pair A-17, B-21	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experi-mental	+49	+47	+48	-25	-17	-21	-18	-26	-22	-4	-4	-4
Control	-8	+9	0	+11	-5	+3	+3	-1	+2	-9	-2	-5

Objective 105. Students will relate stomach functions to digestion. Ten student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

Two problems were identified in the sequence of activities that led to modification of the materials. First, most teachers could not locate stethoscopes and using styrofoam cups with the bottoms removed proved unsatisfactory. Stethoscopes will be included in the kit in the future. Second, students were confusing the starch and sugar tests which were conducted on the same day using one worksheet. One teacher separated the experiments by one day and used separate worksheets with excellent results. The materials were revised to include this procedure and separate worksheets were constructed.

Nearly half of the teachers reported that their most reticent students "suddenly became excited and were deeply involved with this series of activities." Other teachers reported that, much to their surprise, many students were able to work individually on starch and sugar tests. Another surprising result was that many students were familiar with the terms "dissolve" and "solution" and had elementary definitions of these concepts within their grasp.

Because of the large number of activities under this objective, several graphs were constructed for small subgroups of activities. Figure 22 displays the graphs of teachers' ratings of student interest across the series of activities, and Figures 23 and 24 display the graphs of student pleasure and willingness, respectively. The responses for activities 21 to 23 and 24 were especially high.

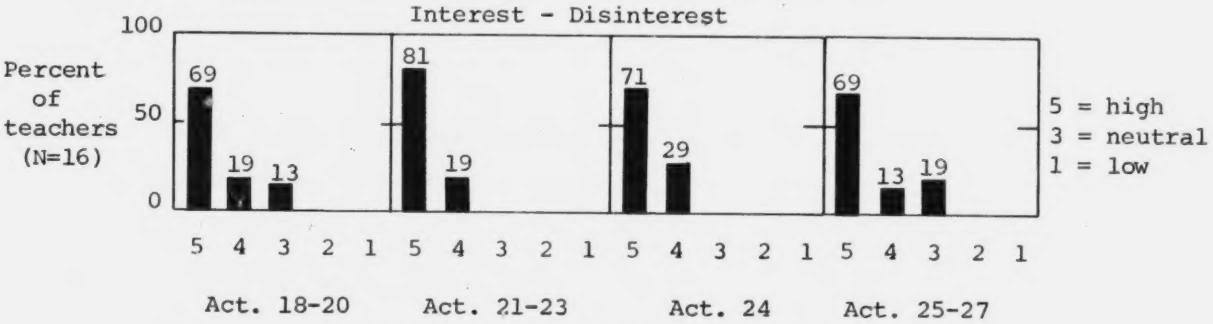


Figure 22. Interest of the majority of students in activities 18 to 27

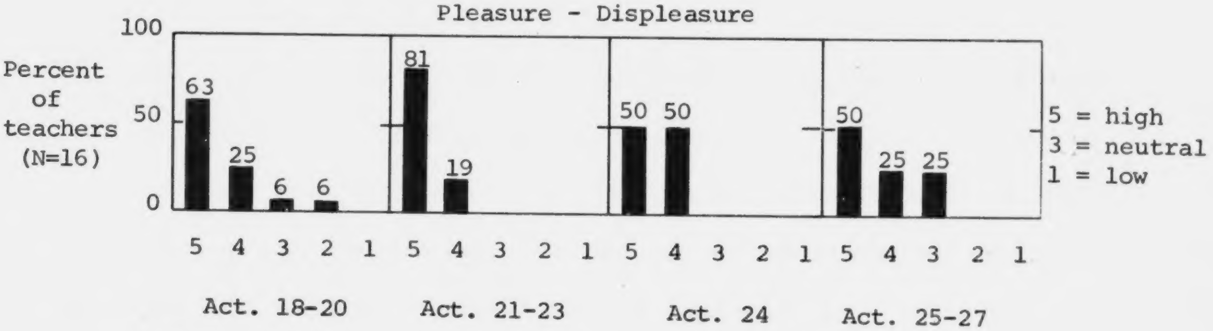


Figure 23. Pleasure of the majority of students in activities 18 to 27

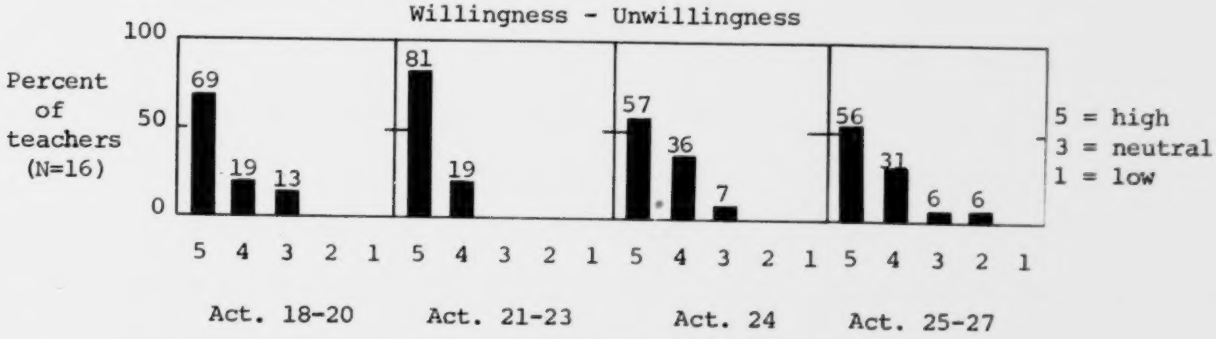


Figure 24. Willingness of the majority of students to participate in activities 18 to 27

Figure 25 shows that the teachers judged this series of activities to be important. Figure 26 shows the proportion of students who were able to perform the behaviors specified by the nine subobjectives of objective 105.

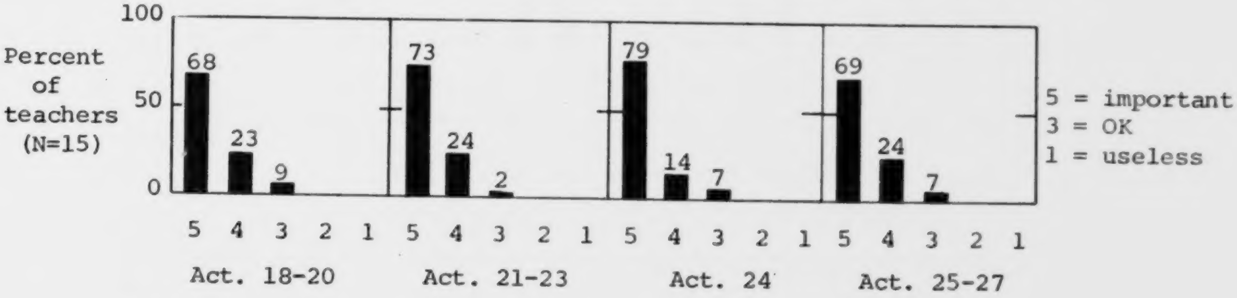


Figure 25. Importance to students of activities 18 to 27

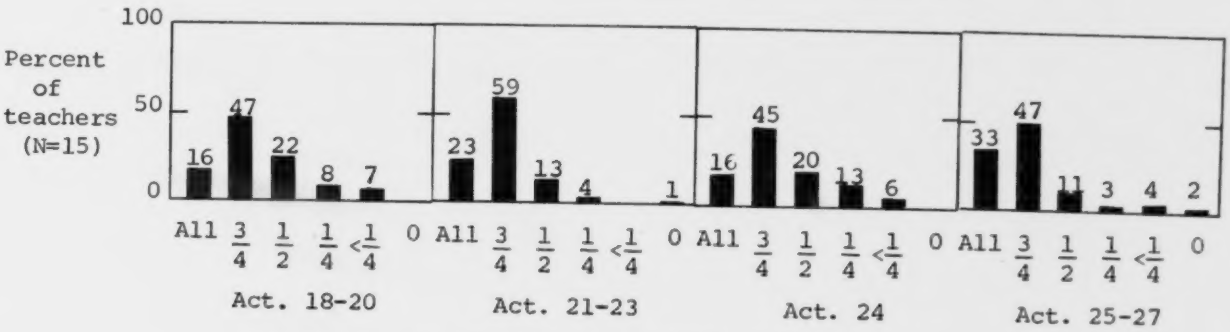


Figure 26. Proportion of students able to perform on subobjectives of objective 105

The range of teachers estimating that three-fourths or more of their students were able to perform the behaviors specified is from a high of 80 percent for activities 25 to 27 to a low of 61 percent for activity 24. In view of the complexity of the tasks, we are very pleased with the results. The range of teachers estimating the ratio of successful students at one-half or more is from a high of 95 percent for activities 21 to 23 to a low of 81 percent for activity 24. Teacher judgment of the importance of the subobjectives was generally quite high (see Figure 27).

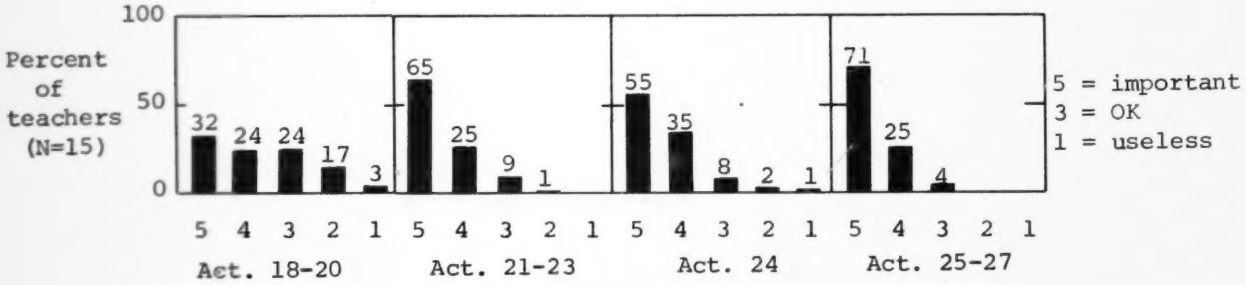
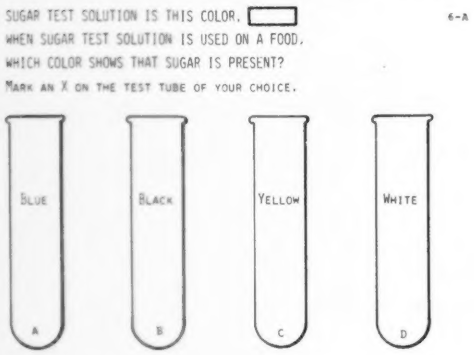
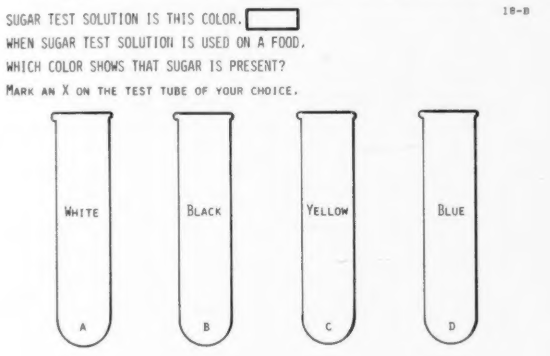


Figure 27. Importance of the subobjectives of objective 105

Two of the test teachers experienced some difficulties with this series of activities, which resulted in some of the low teacher ratings. Based on their difficulties, modifications were made in procedures, worksheets and in the activities.

Six item pairs were designed to sample achievement on objective 105.


SUGAR TEST SOLUTION IS THIS COLOR. ☐
WHEN SUGAR TEST SOLUTION IS USED ON A FOOD,
WHICH COLOR SHOWS THAT SUGAR IS PRESENT?
MARK AN X ON THE TEST TUBE OF YOUR CHOICE.
6-A
BLUE
BLACK
YELLOW
WHITE
A
B
C
D


SUGAR TEST SOLUTION IS THIS COLOR. ☐
WHEN SUGAR TEST SOLUTION IS USED ON A FOOD,
WHICH COLOR SHOWS THAT SUGAR IS PRESENT?
MARK AN X ON THE TEST TUBE OF YOUR CHOICE.
18-B
WHITE
BLACK
YELLOW
BLUE
A
B
C
D

Item pair 6-A, 18-B functions at the cognitive level of comprehension. Mean net gain for the experimental group from pretest to posttest was 51 percent (from 10 to 61 percent). A shift from blue and white to yellow as the correct choice accounted for this gain. A mean net gain of ten percent was achieved by the experimental group for black, choice B in Forms A and B as a response choice. Some students probably confused the results of the starch and sugar tests. The biserial correlations indicate that the items are good discriminators. A mean net loss of one percent in the control group indicates that the experimental group gains can be attributed to the effect of instruction.

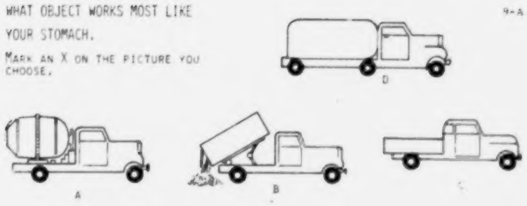
The stem should be revised to read, "Sugar test solution is blue," and eliminate possible confusion by not having color in the test item booklet. The word "blue" was written in the test book for all posttests.

Table 30. Item Responses and Biserial Correlations for Experimental and Control Groups

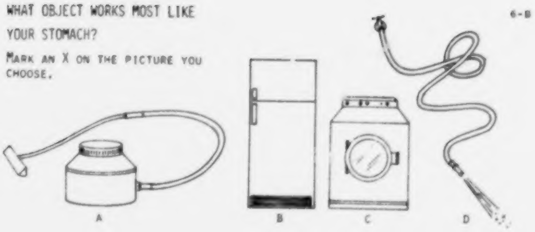
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-6	79	30	11	4	54	0	0	87	20	20	54	7	0	0	-.25	.48
	B-18	87	49	3	16	30	1	0	79	4	14	68	14	0	0	.04	.41
Control	A-6	80	34	9	6	50	1	0	88	30	13	8	50	0	0	-.33	-.12
	B-18	88	40	13	13	32	3	0	80	51	5	10	34	0	0	-.14	-.06

Table 31. Pretest to Posttest Changes (The response choice for A-6 is cited first.)

Item Pair A-6, B-18	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	D	A+D	B	B	B+B	D	A	D+A
Experimental	+50	+52	+51	-10	-16	-13	+9	+11	+10	-47	-45	-45
Control	+2	-3	-1	-4	+2	+3	+4	-8	-2	0	+11	+5


WHAT OBJECT WORKS MOST LIKE YOUR STOMACH.

MARK AN X ON THE PICTURE YOU CHOOSE.


WHAT OBJECT WORKS MOST LIKE YOUR STOMACH?

MARK AN X ON THE PICTURE YOU CHOOSE.

Item pair 9-A, 6-B functions at the cognitive level of analysis. The mean net gain of 25 percent (from 45 to 70 percent) in the experimental group can be accounted for by net losses from all distractor pairs. Although there was a mean net gain of 14 percent from pretest to posttest in the control group, we feel that the 25 percent gain in the experimental group can be attributed to the effect of instruction. Boys scored higher than girls on item 9-A while girls scored higher than boys on item 6-B.

Table 32. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
		N	Percent of N						N	Percent of N							
			A	B	C	D	M	O		A	B	C	D	M	O	Pre	Post
Experimental	A-9	79	61	29	4	6	0	0	87	77	21	0	2	0	0	.41	.66
	B-6	87	40	15	30	14	1	0	79	14	4	63	19	0	0	.54	.48
Control	A-9	80	60	24	4	13	0	0	88	70	13	3	11	2	0	.41	.48
	B-6	88	36	15	33	16	0	0	80	29	11	50	10	0	0	.28	.65

Table 33. Pretest to Posttest Changes (The response choice for A-9 is cited first.)

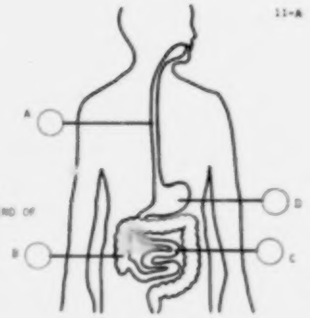
Item Pair A-9, B-6	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	D	B+D	C	A	C+A	D	B	D+B
Experimental	+16	+33	+25	-8	+5	-1	-4	-26	-16	-4	-11	-8
Control	+10	+17	+14	-11	-6	-8	-1	-7	-4	-2	-4	-3

Interviews with students identified varying degrees of understanding of the concept measured by the item. Students choosing the pickup truck or tank truck chose them because they "carried things like the stomach carries food." Students choosing the dump truck reasoned that it "carried things and dumped them like the stomach does with food." The carrying, mixing and dumping processes of the cement truck were clearly explained as being analogous to stomach action by students choosing this response.

Teachers' comments indicate that the art work on the tank truck should be improved and the "What object" should be replaced by "Which truck" in the stem of Form A.

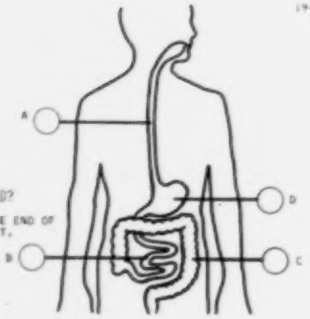
11-A

AFTER FOOD LEAVES THE MOUTH,
WHERE IS DIGESTIVE JUICE ADDED?
MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT TOUCHES THE PART.



19-B

AFTER FOOD LEAVES THE MOUTH,
WHERE IS DIGESTIVE JUICE ADDED?
MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT TOUCHES THE PART.



Item pair 11-A, 19-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 17 percent (from 45 to 62 percent). This gain can be attributed to losses in the response choices for the large and small intestines. There was a mean net gain of eight percent (from 14 to 22 percent) for the esophagus as a distractor. It may be necessary to add instructions to the Teacher's Guide to help the students differentiate between the esophagus and the stomach. It is also possible that some students think digestive juices are added in the esophagus. Teachers should be alerted to this possible problem.

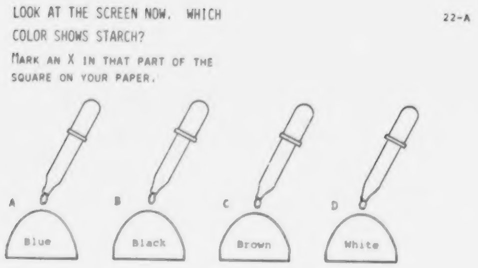
There was a mean net gain of six percent from pretest to posttest in the control group. The larger pretest to posttest gain in the experimental group indicates that student success in the experimental group is attributable to the effects of instruction. The biserial correlations indicate that the items are good discriminators. The instructions in the stem should be changed to "Mark an X on the line...," and the figure should be changed to correspond with the other figures in the test.

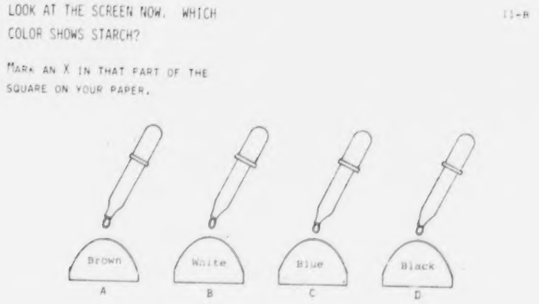
Table 34. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-11	79	5	16	29	49	0	0	87	22	5	10	62	1	0	.03	.34
	B-19	87	23	20	14	41	2	0	79	23	8	8	62	0	0	.15	.55
Control	A-11	80	8	15	46	31	0	0	88	10	11	30	47	2	0	.26	.51
	B-19	88	18	23	18	40	1	0	80	18	18	29	36	0	0	.39	.36

Table 35. Pretest to Posttest Changes
(The response choice for A-11 is cited first.)

Item Pair A-11, B-19	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	C	B+C	C	B	C+B
Experi-mental	+13	+21	+17	+17	0	+8	-11	-6	-9	-19	-12	-15
Control	+16	-4	+6	+2	0	+1	-4	+11	+3	-16	-5	-10


LOOK AT THE SCREEN NOW. WHICH
COLOR SHOWS STARCH?
MARK AN X IN THAT PART OF THE
SQUARE ON YOUR PAPER.
22-A
A
Blue
B
Black
C
Brown
D
White


LOOK AT THE SCREEN NOW. WHICH
COLOR SHOWS STARCH?
MARK AN X IN THAT PART OF THE
SQUARE ON YOUR PAPER.
11-B
Brown
A
White
B
Blue
C
Black
D

With item pair 22-A, 11-B functioning at the cognitive level of comprehension, a mean net gain from pretest to posttest of 53 percent (from 14 to 67 percent) in the experimental group can be accounted for by a shift from choosing brown and white. There was a mean net gain of four percent in choosing blue in the experimental group. Some students may have problems distinguishing between blue and black in the projected slide. This indicates that yellow, a color obtained with the sugar test solution, could be a possible distractor instead of blue. Also, since no squares appear in the test paper, the instruction in the stem should read, "Mark an X on your choice." Since the mean net gain from pretest to posttest in the control group was only seven percent (from eight to 15 percent), the large gains achieved by the experimental group can be attributed to the effect of instruction.

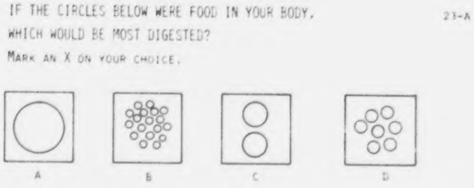
Table 36. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-22	79	6	11	19	63	0	0	87	13	68	17	2	0	0	.07	.54
	B-11	87	8	54	21	16	1	0	79	5	5	24	66	0	0	-.24	.28
Control	A-22	80	31	8	19	41	1	0	88	27	16	14	42	1	0	-.11	.16
	B-11	88	15	60	15	8	2	0	80	10	53	25	13	0	0	.60	-.18

Table 37. Pretest to Posttest Changes
(The response choice for A-22 is cited first.)

Item Pair A-22, B-11	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	D	B+D	A	C	A+C	C	A	C+A	D	B	D+B
Experi-mental	+57	+50	+53	+7	+3	+4	-2	-3	-2	-61	-49	-55
Control	+8	+5	+7	-4	+10	+3	-5	-5	-5	+1	-7	-4

Item pair 23-A, 16-B provides baseline information and functions at the cognitive level of comprehension. The pretest results on this item pair, for both the experimental and control groups, indicate that, prior to instruction, the majority of these populations understands that pieces of food become smaller during the digestion process. There is some indication, however, that the word "most" has caused students to choose the correct response on the pretest. The mean net gain from pretest to posttest in the experimental group was 14 percent (from 74 to 88 percent), accounted for by a shift from all distractor pairs. The mean net gain from pretest to posttest in the control group was six percent (from 81 to 87 percent). The control pretest mean on this item pair was higher than the mean for the experimental group; but the mean net gain in the experimental group, that we attribute to instruction, was greater than the mean net gain of the control group.


IF THE CIRCLES BELOW WERE FOOD IN YOUR BODY, WHICH WOULD BE MOST DIGESTED?
MARK AN X ON YOUR CHOICE.

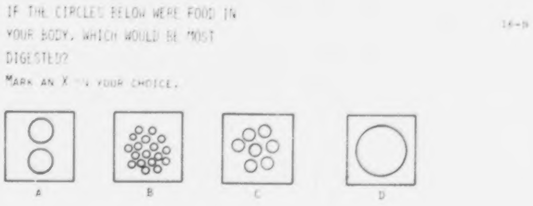

IF THE CIRCLES BELOW WERE FOOD IN YOUR BODY, WHICH WOULD BE MOST DIGESTED?
MARK AN X ON YOUR CHOICE.

Table 38. Item Responses and Biserial Correlations
for Experimental and Control Groups

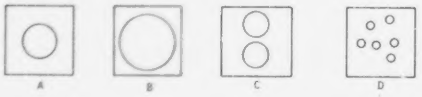
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-23	79	9	82	5	4	0	0	87	8	86	2	3	0	0	.62	.85
	B-16	87	10	67	6	17	0	0	79	1	90	4	5	0	0	.51	.62
Control	A-23	80	4	88	3	5	1	0	88	2	92	2	1	2	0	.31	.61
	B-16	88	3	75	5	17	0	0	80	4	83	8	5	1	0	.32	.47

Table 39. Pretest to Posttest Changes
(The response choice for A-23 is cited first.)

Item Pair A-23, B-16.				Percent Change, Pretest to Posttest								
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	D	A+D	C	A	C+A	D	C	D+C
Experi-mental	+4	+23	+14	-1	-12	-6	-3	-9	-6	-1	-2	-2
Control	+4	+8	+6	-2	-12	-8	-1	+1	0	-4	+3	-1

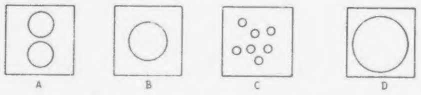
WHICH PICTURE SHOWS THE PIECE
OF FOOD MOST DISSOLVED?
MARK AN X ON YOUR CHOICE.

29-A



WHICH PICTURE SHOWS THE PIECE
OF FOOD MOST DISSOLVED?
MARK AN X ON YOUR CHOICE.

30-B



Item pair 29-A, 30-B provides baseline information and functions at the cognitive level of comprehension. The high pretest scores on this item pair were surprising to the BSCS staff, but there is some indication that the word "most" may act as a clue, as with the previous item pair. During staff visits to the experimental group classrooms, students were interviewed and asked why they chose their particular response choice for this item pair. The term "dissolve" was associated by the EMH students with terms such as "melt," "disappear," and "goes away," indicating an elementary level of understanding of the dissolving process.

Table 40. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-29	79	8	3	0	89	1	0	87	3	3	3	90	0	0	.39	.69
	B-30	87	7	11	75	6	0	0	79	0	4	94	1	1	0	.43	.64
Control	A-29	80	5	4	3	86	1	0	88	3	3	2	90	1	0	.18	.54
	B-30	88	5	5	80	8	3	0	80	0	5	91	3	0	0	.36	.09

Table 41. Pretest to Posttest Changes
(The response choice for A-29 is cited first.)

Item Pair A-29, B-30	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	C	D+C	A	B	A+B	B	D	B+D	C	A	C+A
Experimental	+1	+19	+10	-5	-7	-7	0	-5	-3	+3	-7	-2
Control	+4	+11	+7	-2	0	-1	-1	-5	-3	-1	-5	-3

The mean net gain in the experimental group of ten percent (from 82 to 92 percent) was greater than the mean net gain of seven percent (from 83 to 90 percent) by the control group. However, since differences between the two groups are so small, experimental group gains cannot be attributed to instruction. In spite of the high success rate in the experimental group, the biserial correlations indicate that the items are good discriminators.

Objective 106. *Students will infer functions of parts of the circulatory system*. Eleven student activities and other instructional strategies were designed to develop student competencies to achieve this objective. Sixty percent of the teachers used the strategies as described, 34 percent reported some modification and six percent reported much modification. All teachers who followed the prescribed strategies reported them successful. Teacher feedback indicated that many of the students were familiar with the terms "heart," "vessel" and "pulse," but that the exact nature of the circulatory system was not well known.

The major problem with the materials was the inability of some teachers to assemble the heart model and make it work properly. This problem will be overcome by the functioning torso. The "hands-on" philosophy of the program has been extremely successful in this series of activities, as evidenced by only one of many comments we received: "The model of the circulatory system has been one of the most fascinating, attention getting and keeping devices of the program so far. The boys love it! By allowing them to experiment in their free time with the model they have discovered much of the things about circulation on their own. This device aided even my slowest one in discussing the questions freely and in a knowledgeable manner."

Three feedback forms were used to collect teacher data across activities 28 to 38. Figures 28 to 30 show the high level of response for student interest, pleasure and willingness.

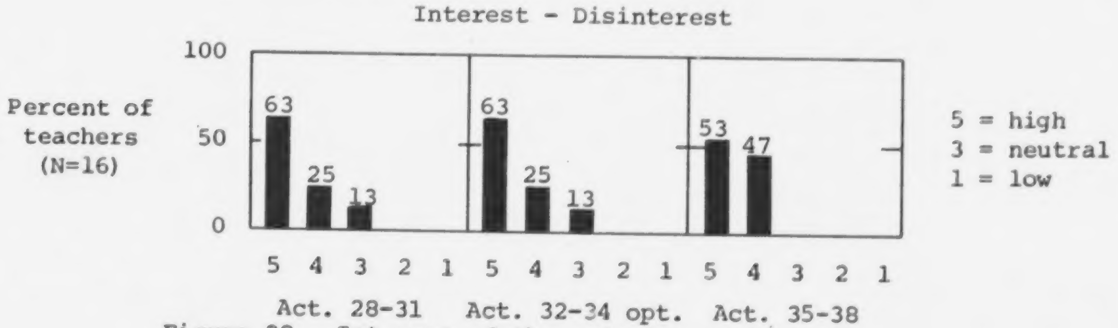


Figure 28. Interest of the majority of students in activities 28 to 38

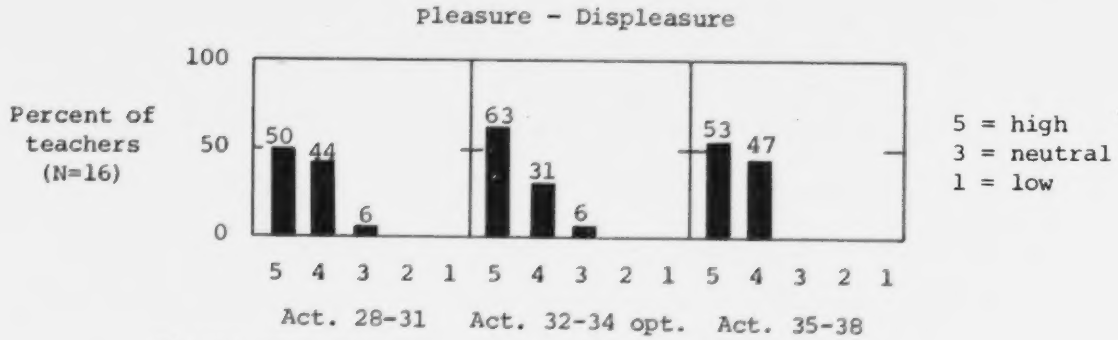


Figure 29. Pleasure of the majority of students in activities 28 to 38

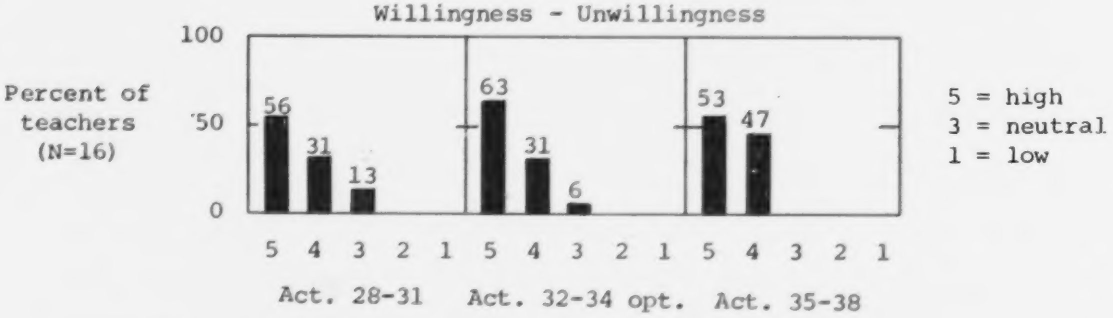


Figure 30. Willingness of the majority of students to participate in activities 28 to 38

Most teachers felt the activities under objective 106 were important for their students. One teacher, however, felt that her students already knew the relationship between heartbeat and pulse and marked this series of activities as unimportant for her students. Two teachers felt that the optional activity 34 was not necessary and marked it as not being useful (see Figure 31).

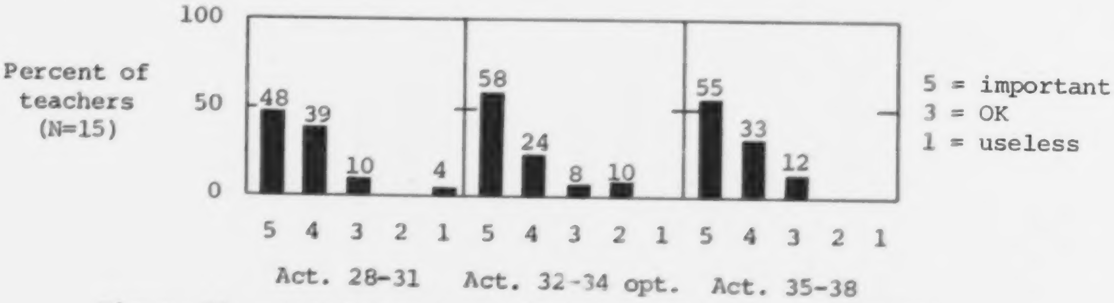


Figure 31. Importance to students of activities 28 to 38

Figure 32 shows the proportion of students who were able to perform the behaviors specified by the six subobjectives of objective 106.

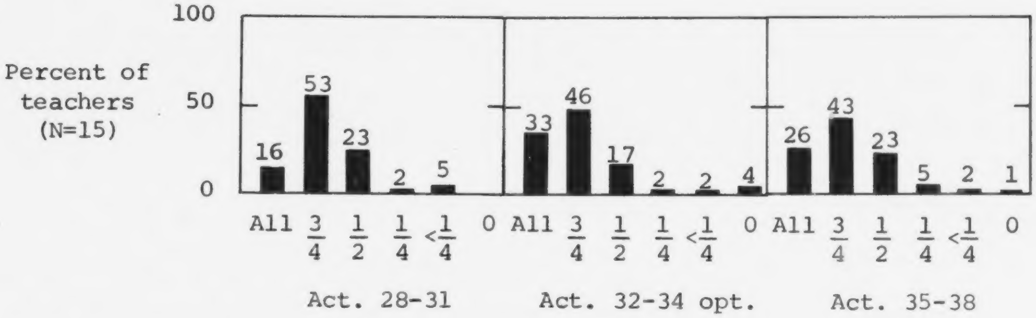


Figure 32. Proportion of students able to perform on subobjectives of objective 106

The range of teachers estimating that three-fourths or more of their students experienced success in performing the desired behaviors in this series was from a maximum of 75 percent for activities 32 to 34 optional to a low of 69 percent for the remaining activities. The percentage estimating that one-half or more of their students successfully performed the desired behaviors was 93 percent for activities 28 to 31 and 92 percent for activities 32 to 34 optional and 35 to 38.

The percentage of teachers rating this series of subobjectives as important was quite high. The ratings of the teachers who experienced problems also stand out clearly (see Figure 33).

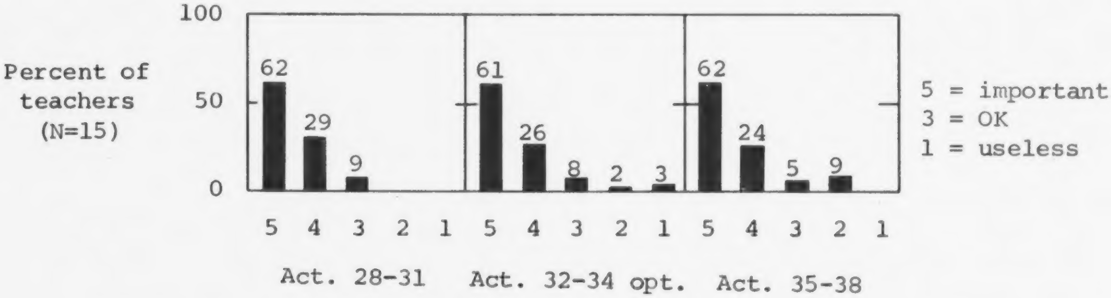
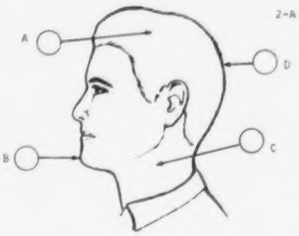


Figure 33. Importance of the subobjectives of objective 106

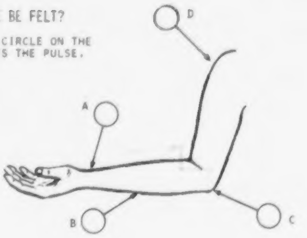
Five item pairs were designed to sample achievement on this objective.

WHERE CAN A PULSE BE FELT?
MARK AN X IN THE CIRCLE ON THE ARROW THAT TOUCHES THE PULSE.



2-A

WHERE CAN A PULSE BE FELT?
MARK AN X IN THE CIRCLE ON THE ARROW THAT TOUCHES THE PULSE.



15-B

Item pair 2-A, 15-B provides achievement data for this objective and functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 23 percent (from 69 to 92 percent). Since there was a mean net loss of 16 percent (from 71 to 55 percent) in the control group, we conclude that the experimental group gains were due to the effect of instruction. The biserial

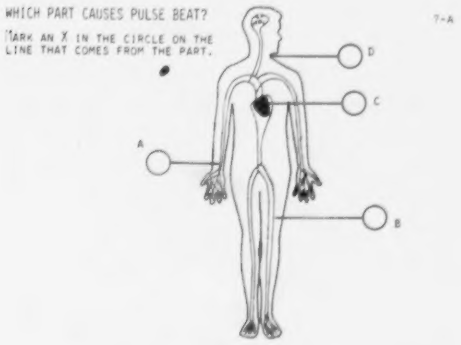
Table 42. Item Responses and Biserial Correlations
for Experimental and Control Groups

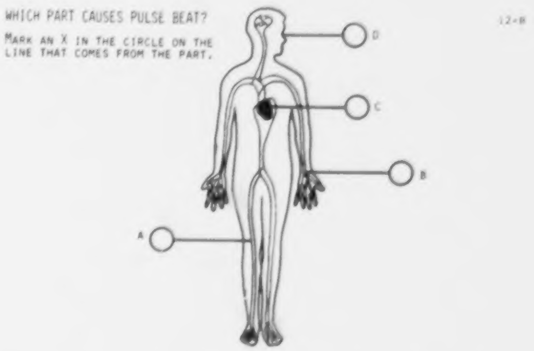
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-2	79	13	16	66	5	0	0	87	2	7	89	2	0	0	.41	.76
	B-15	87	72	3	7	16	0	0	79	95	1	1	3	0	0	.64	.50
Control	A-2	80	8	9	66	15	3	0	88	9	8	67	15	1	0	.61	.41
	B-15	88	76	6	5	14	0	0	80	43	44	5	9	0	0	.28	.52

Table 43. Pretest to Posttest Changes
(The response choice for A-2 is cited first.)

Item Pair A-2, B-15	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	D	A+D	B	C	B+C	D	B	D+B
Experimental	+23	+23	+23	-11	-13	-13	-9	-6	-7	-3	-2	-2
Control	+1	-23	-16	+1	-5	-2	-1	0	0	0	+38	+19

correlations indicate that the items are good discriminators. The instructions in the stem should be changed to "Mark an X on the line..."


WHICH PART CAUSES PULSE BEAT?
MARK AN X IN THE CIRCLE ON THE LINE THAT COMES FROM THE PART.
7-A
D
C
A
B


WHICH PART CAUSES PULSE BEAT?
MARK AN X IN THE CIRCLE ON THE LINE THAT COMES FROM THE PART.
12-B
D
C
B
A

Item pair 7-A, 12-B provides baseline information for this objective and functions at the cognitive level of comprehension. The mean net gain from pretest to posttest for the experimental group was three percent (from 79 to 82 percent) and the control group showed a mean net loss of two percent (from 71 to 69 percent). Although the experimental group gain attributable to the effect of instruction was small, the response pattern for the distractors yields valuable information. A total of 14 percent of the experimental group chose the pulse site at the wrist as causing pulse beat, after instruction. A possible vocabulary problem may be present in this item. The stem should be changed to "Which part makes the pulse beat," thus enabling the staff to determine if the word "cause" is the source of the problem. The

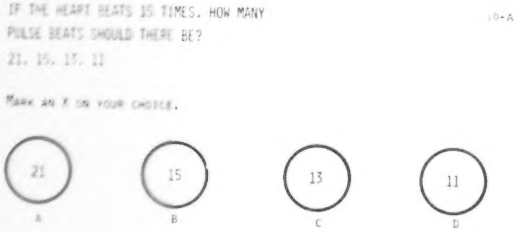
Table 44. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-7	79	13	1	81	4	0	1	87	11	2	84	1	1	0	.39	.64
	B-12	87	0	20	78	2	0	0	79	1	18	80	1	0	0	.22	.34
Control	A-7	80	13	0	80	6	1	0	88	30	2	64	5	0	0	.41	-.13
	B-12	88	5	27	63	5	1	0	80	1	23	75	0	1	0	-.08	.20

Table 45. Pretest to Posttest Changes
(The response choice for A-7 is cited first.)

Item Pair A-7, B-12	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	B	A+B	B	A	B+A	D	D	D+D
Experimental	+3	+2	+3	-2	-2	-3	+1	+1	+2	-3	-1	-2
Control	-16	+12	-2	+17	-4	+7	+2	-4	-1	-1	-5	-2

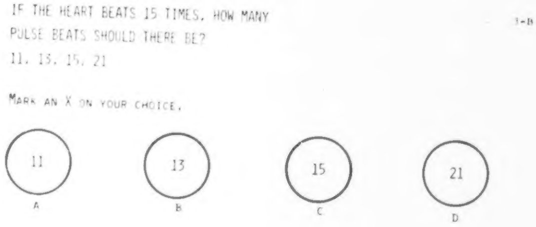
biserial correlations indicate that the items are reasonable discriminators.


10-A

IF THE HEART BEATS 15 TIMES. HOW MANY
PULSE BEATS SHOULD THERE BE?
21. 15. 13. 11

MARK AN X ON YOUR CHOICE.

21
A
15
B
13
C
11
D


3-B

IF THE HEART BEATS 15 TIMES. HOW MANY
PULSE BEATS SHOULD THERE BE?
11. 13. 15. 21

MARK AN X ON YOUR CHOICE.

11
A
13
B
15
C
21
D

Item pair 10-A, 3-B functions at the cognitive level of application. Mean net gain from pretest to posttest for the experimental group was 14 percent (from 42 to 56 percent). There was a mean net loss of nine percent (from 46 to 37 percent) in the control group. The experimental group gains can be accounted for by a shift from choosing 21 and 11. However, the gain of three percent (from 12 to 15 percent) on 13 indicates that some students with visual reception problems may not be able to discriminate between the 13 and the 15. A reasonable sequence of response choices would be 11, 15, 17 and 21. There is clearly an effect due to instruction in the experimental group and the biserial correlations indicate that the items are excellent discriminators.

Table 46. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
		N	Percent of N						N	Percent of N							
			A	B	C	D	M	O		A	B	C	D	M	O	Pre	Post
Experimental	A-10	79	28	46	13	14	0	0	87	29	41	22	8	0.	0	.31	.42
	B-3	87	15	11	38	34	1	0	79	9	8	71	11	0	0	.46	.52
Control	A-10	80	24	45	18	14	0	0	88	16	35	31	16	2	0	.57	.25
	B-3	88	10	20	47	20	2	0	80	4	29	39	27	1	0	.44	.69

Table 47. Pretest to Posttest Changes (The response choice for A-10 is cited first.)

Item Pair A-10, B-3	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experimental	-5	+33	+14	+1	-23	-11	+9	-3	+3	-6	-6	-7
Control	-10	-8	-9	-8	+7	-1	+13	+9	+11	+2	-6	-2

Item pair 16-A, 13-B provides baseline information for this objective and functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 12 percent (from 71 to 83 percent) and mean net gain for the control group was 11 percent (from 51 to 62 percent). Experimental group gains are attributable to shifts from air and saliva to the correct response, blood. There was

WHICH OF THESE DOES THE HEART PUMP:
AIR, BLOOD, SALIVA, STOMACH JUICES?
MARK AN X ON YOUR CHOICE.
16-A

AIR	BLOOD	SALIVA	STOMACH JUICES
A	B	C	D

WHICH OF THESE DOES THE HEART PUMP:
STOMACH JUICES, SALIVA, BLOOD, AIR?
MARK AN X ON YOUR CHOICE.
13-B

STOMACH JUICES	SALIVA	BLOOD	AIR
A	B	C	D

a small gain of two percent (from three to five percent) in choosing stomach juices. Since the term "stomach juices" has been changed to "digestive juices" in the *ME NOW* materials, this change should also be made in this item. This inconsistency in terminology could account for a somewhat lower gain than was anticipated.

Pretest to posttest gains are similar in the experimental and control groups. However, the higher percentage of students choosing the correct response in the experimental group (83 versus 62 percent), together with the large gains in biserial correlations (.26 in both forms) for the experimental group, leads us to conclude that there was an effect due to instruction measured by this item pair.

Table 48. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
		N	Percent of N						N	Percent of N							
			A	B	C	D	M	O		A	B	C	D	M	O	Pre	Post
Experimental	A-16	79	16	70	10	4	0	0	87	9	85	0	5	1	0	.54	.80
	B-13	87	3	2	72	20	2	0	79	5	3	80	13	0	0	.29	.55
Control	A-16	80	25	58	5	11	1	0	88	25	53	9	10	2	0	.46	.49
	B-13	88	7	1	45	44	2	0	80	3	6	71	20	0	0	.51	.28

Table 49. Pretest to Posttest Changes
(The response choice for A-16 is cited first.)

Item Pair A-16, B-13	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experimental	+15	+8	+12	-7	-7	-7	-10	+1	-5	+1	+2	+2
Control	-5	+16	+11	0	+22	+12	+4	+5	+5	-1	-4	-2

IF THE PULSE BEATS 13 TIMES. HOW MANY TIMES DID THE HEART BEAT? 25-A
MARK AN X ON YOUR CHOICE.

11
A
13
B
15
C
21
D

IF THE PULSE BEATS 13 TIMES. HOW MANY TIMES DID THE HEART BEAT? 28-B
MARK AN X ON YOUR CHOICE.

21
A
15
B
13
C
11
D

Item pair 25-A, 28-B functions at the cognitive level of application. Mean net gain from pretest to posttest for the experimental group was 21 percent (from 28 to 49 percent) and can be accounted for by shifts from all distractors. However, 33 percent of the experimental group is still choosing 15 instead of 13 for the correct response. This result, together with the result from item pair 10-A, 3-B, brings us to the definite conclusion that many EMH students with visual reception problems cannot distinguish between 13 and 15. The sequence of 11, 13, 17 and 21 should be used for this item.

There was a mean net loss from pretest to posttest for the control group of four percent (from 34 to 30 percent). This leads to the conclusion that this item pair measures a definite gain due to the effect of instruction.

Table 50. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-25	79	14	33	37	16	0	0	87	8	43	38	11	0	0	.41	.50
	B-28	87	24	43	24	9	0	0	79	13	28	56	4	0	0	.67	.63
Control	A-25	80	15	31	36	18	0	0	88	15	25	44	14	2	0	.60	.32
	B-28	88	11	32	36	19	1	0	80	24	38	35	4	0	0	.34	.78

Table 51. Pretest to Posttest Changes
(The response choice for A-25 is cited first.)

Item Pair A-25, B-28	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experimental	+10	+32	+21	-6	-5	-5	+1	-15	-7	-5	-11	-8
Control	-6	-1	-4	0	-15	-7	+8	+6	+7	-4	+13	+5

Objective 107. Students will infer a relationship between food and blood and describe barriers between them. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective. Eighty-one percent of the teachers used the prescribed strategies, 19 percent reported some modifications. A few minor problems with worksheets were encountered and the worksheets have been revised.

Figure 34 shows that student reactions were high, but not as high as with some previous activities. Some of the activities in this series utilize slides and not laboratory equipment. The following teacher's comment illustrates the students' reaction, "Activities limited to only questions and the slides seemed to have 'turned the boys off' somewhat especially when they have tasted the excitement of being allowed to totally participate in some of the other activities. You have also made my job that much more challenging in that I must keep participation in the other subject areas equally as interesting and challenging."

Figure 35 shows that the activities were considered important for EMH students.

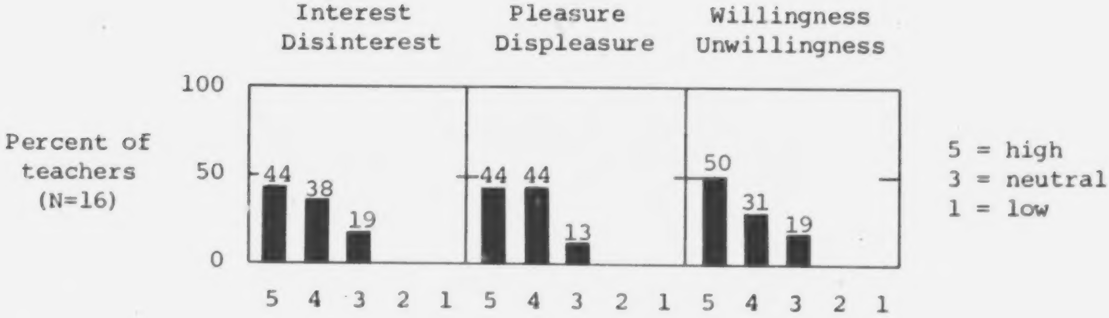


Figure 34. Reaction of the majority of students to activities 39 to 41

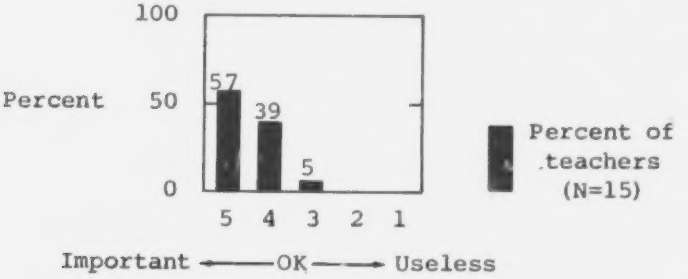


Figure 35. Importance to students of activities 39 to 41

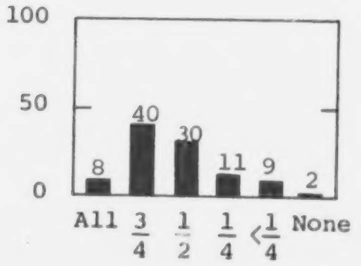


Figure 36. Proportion of students able to perform on subobjectives of objective 107

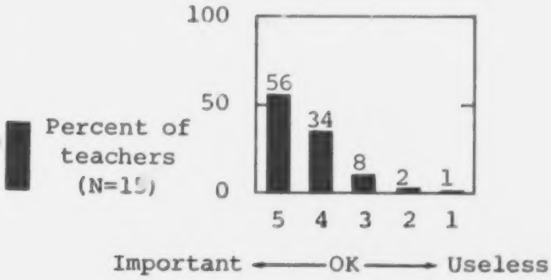
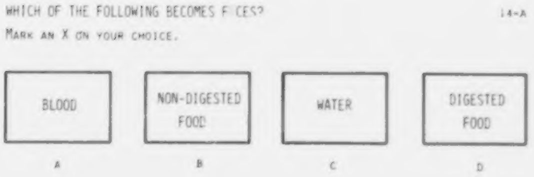
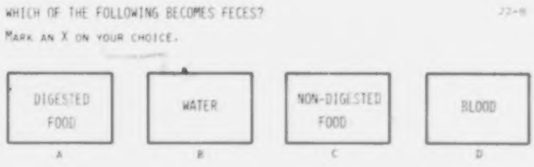


Figure 37. Importance of the subobjectives

Figure 36 shows the proportion of students who were able to perform the behaviors specified by the two subobjectives of objective 107. Forty-eight percent of the teachers reported that three-fourths or more of their students could perform the behaviors specified by the subobjectives. Seventy-eight percent reported that one-half or more of their students could perform the specified behaviors. Figure 37 shows that teachers judged the subobjectives to be important.

Four item pairs were designed to sample achievement on this objective.


WHICH OF THE FOLLOWING BECOMES FECES?
MARK AN X ON YOUR CHOICE.
14-A
BLOOD
A
NON-DIGESTED FOOD
B
WATER
C
DIGESTED FOOD
D


WHICH OF THE FOLLOWING BECOMES FECES?
MARK AN X ON YOUR CHOICE.
22-B
DIGESTED FOOD
A
WATER
B
NON-DIGESTED FOOD
C
BLOOD
D

Item pair 14-A, 22-B functions at the cognitive level of knowledge. This item pair was relatively difficult with a mean net gain from pretest to posttest of eight percent (from 26 to 34 percent) for the experimental group. Almost unanimously, teachers recommended that the response choices be placed in the stem and read to the students. This should be changed in the revised items. There was a mean net gain from pretest to posttest of two percent in the control group. The biserial correlations in both Forms A and B posttests indicate that the items are good discriminators. The change in biserial correlations from

Table 52. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-14	79	22	29	15	33	1	0	87	22	24	17	37	0	0	.04	.33
	B-22	87	30	21	23	25	1	0	79	28	11	44	16	0	0	.04	.40
Control	A-14	80	14	36	6	43	1	0	88	16	25	19	39	1	0	.19	.28
	B-22	88	31	25	27	16	1	0	80	21	16	41	21	0	0	.05	.10

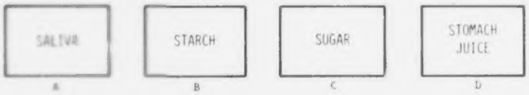
Table 13. Pretest to Posttest Changes
(The response choice for A-14 is cited first.)

Item Pair A-14, B-22	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experimental	-5	+21	+8	0	-9	-5	+2	-10	-4	+4	-2	+2
Control	-9	+14	+2	+2	+5	+3	+13	-9	+2	-4	-10	-7

pretest to posttest in the experimental group indicates a significant change attributable to instruction.

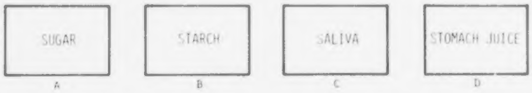
WHICH MATERIAL CAN BE FOUND IN BLOOD:
SALIVA, STARCH, SUGAR, STOMACH JUICE?
MARK AN X ON YOUR CHOICE.

26-A



WHICH MATERIAL CAN BE FOUND IN BLOOD:
SUGAR, STARCH, SALIVA, STOMACH JUICE?
MARK AN X ON YOUR CHOICE.

26-B



Item pair 26-A, 26-B functions at the cognitive level of knowledge. There was a net loss from pretest to posttest of five percent (from 38 to 33 percent) in the experimental group, which is accounted for by shifts to choosing starch and stomach juice. Two possible problems are identified here. First, the conversion of starch to sugar during digestion needs to be more explicit in the experiments conducted by the students. By substituting diabetic crackers that contain no sugar and give a positive starch test, it will be possible to show more clearly the conversion of starch to sugar. The crackers that were used during instruction yielded positive sugar and starch tests prior to digestion, thus making any conclusion concerning starch-to-sugar conversion very nebulous and difficult. The second problem concerns the use of the term

Table 54. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-26	79	11	6	37	46	0	0	87	20	16	28	37	0	0	-.06	.57
	B-26	87	38	16	24	22	0	0	79	39	14	10	37	0	0	.46	.72
Control	A-26	80	16	15	35	34	0	0	88	13	14	38	35	1	0	.38	.33
	B-26	88	51	8	17	23	1	0	80	41	11	15	33	0	0	.45	.40

"stomach juice." This has now been changed to "digestive juice" in the *ME NOW* materials and this same change should be made here.

There was also a mean net loss from pretest to posttest of four percent in the control group. From the response data alone it appears that this item did not measure any significant effect due to instruction. However, an examination of the biserial correlations indicates a strong improvement in the experimental group and a decline in the control group. This leads to the conclusion that this item pair did measure an effect due to instruction in the experimental group.

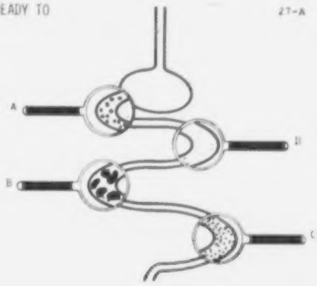
Table 55. Pretest to Posttest Changes (The response choice for A-26 is cited first.)

Item Pair A-26, B-26	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	C	A+C	B	B	B+B	D	D	D+D
Experi-mental	-9	+1	-5	+9	-14	-3	+10	-2	+4	-9	+15	+3
Control	+3	-10	-4	-3	-2	-3	-1	+3	+2	+1	+10	+6

Item pair 27-A, 29-B functions at the cognitive level of application. The mean net gain from pretest to posttest of 21 percent (from 61 to 82 percent) in the experimental group can be attributed to shifts to the correct response from all distractors. There was a mean net gain of eight percent (from 57 to 65 percent) in the control group. This result leads to the conclusion that this item pair measures an

WHICH PIECES OF FOOD ARE MOST READY TO GO INTO THE BLOOD?
MARK AN X ON YOUR CHOICE.

27-A



WHICH PIECES OF FOOD ARE MOST READY TO GO INTO THE BLOOD?
MARK AN X ON YOUR CHOICE.

29-B

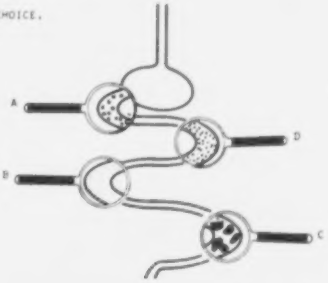


Table 56. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-27	79	3	13	18	66	1	0	87	3	5	7	84	1	0	.63	.86
	B-29	87	10	56	21	9	2	0	79	6	80	9	5	0	0	.64	.85
Control	A-27	80	8	14	24	54	1	0	88	7	6	10	75	2	0	.32	.52
	B-29	88	9	60	17	10	3	0	80	14	54	28	5	0	0	.67	.29

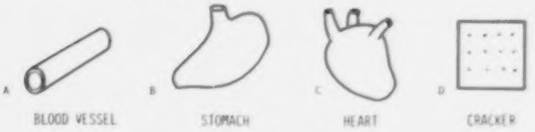
Table 57. Pretest to Posttest Changes
(The response choice for A-27 is cited first.)

Item Pair A-27, B-29	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	A	A+A	B	C	B+C	C	D	C+D
Experimental	+18	+24	+21	0	-4	-3	-8	-12	-10	-11	-4	-7
Control	+21	-6	+8	-1	+5	+1	-8	+11	+1	-14	-5	-9

increase in learning due to the effect of instruction. Student interviews confirmed this conclusion. A typical response was, "Since I can't see anything in blood, pieces of food must be awfully small if they are there." The biserial correlations for the experimental group are exceptionally strong.

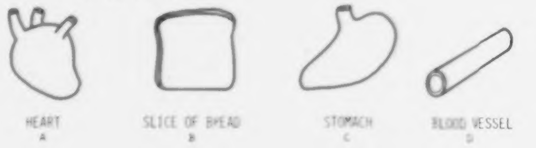
28-A

SUGAR IN YOUR ARM WAS ONCE A PART OF:
BLOOD VESSEL. STOMACH. HEART. CRACKER.
MARK AN X ON YOUR CHOICE.



14-B

SUGAR IN THE BLOOD IN YOUR TOE WAS
ONCE A PART OF: HEART. BREAD. STOMACH.
BLOOD VESSEL.
MARK AN X ON YOUR CHOICE.



Item pair 28-A, 14-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 11 percent (from 19 to 30 percent), and for the control group there was a mean net loss of four percent (from 25 to 21 percent). The biserial correlations for the experimental group were more uniform than were those obtained for the control group, and also indicated that the items are reasonably good discriminators. However, the entire response pattern reflects some confusion, even though there was a shift from choosing the blood and stomach to choosing the cracker. After instruction in the experimental group, 37 percent chose the blood vessel, 15 percent chose the stomach, and 18 percent chose the heart. If one considers the item in a "Gestalt" view, any of the four choices would be correct, since the sugar in the arm was once inside of the blood vessels, heart and stomach. Although the item does reflect growth due to instruction, it should either be revised or discarded, since the apparent confusion is considered to be attributable to the item and probably not to instruction.

Table 58. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-28	79	29	27	18	27	0	0	87	41	8	16	34	0	0	.09	.32
	B-14	87	16	18	18	53	1	0	79	20	25	22	33	0	0	.58	.39
Control	A-28	80	34	13	16	36	0	0	88	41	23	16	19	1	0	.29	-.04
	B-14	88	22	14	11	53	0	0	80	16	24	15	45	0	0	.32	.54

Table 59. Pretest to Posttest Changes (The response choice for A-28 is cited first.)

Item Pair A-28, B-14	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	D	A+D	B	C	B+C	C	A	C+A
Experi-mental	+7	+14	+11	+12	-20	-4	-19	+4	-7	-2	+4	+1
Control	-17	+10	-4	+7	-8	-1	+10	+4	+7	0	-6	-3

Objective 108. Students will observe and describe movement of solutions through membrane barriers. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective. Fifty percent of the teachers used the strategies as described, 44 percent reported some modification. Some teachers experienced difficulties in opening the collodion tubing even though they had practiced this during the training session in Boulder. Consequently, instructions on how to open the tubing were included in the revised materials.

Figure 38 shows that student attitudes were very high for this series of activities. Two typical comments from teachers were, "Once the color change began to take place in the smaller tube, the eyes of ten young men practically popped out of their heads." "Wow!! My usual deadheads were so excited and motivated. I had told them the day before that some magic happens in our intestines 'but,' I said, 'you won't believe me if I tell you so you'll have to wait and see.'"

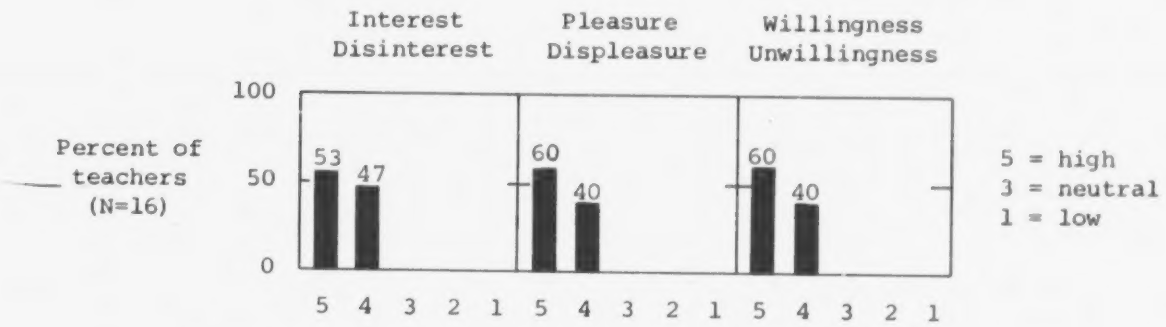


Figure 38. Reaction of the majority of students to activities 42 to 44

Figure 39 shows that the activities are important for EMH students.

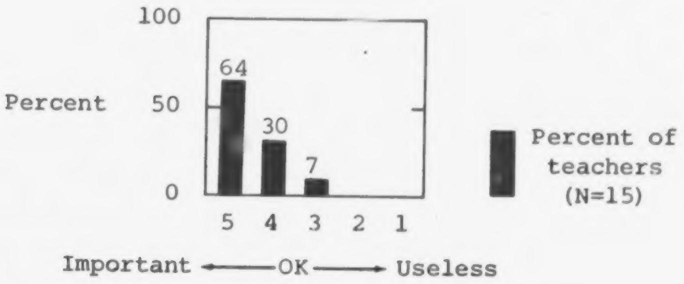


Figure 39. Importance to students of activities 42 to 44

Figure 40 shows the proportion of students able to perform the behaviors specified by the three subobjectives of objective 108. Sixty-six percent of the teachers estimated that three-fourths or more of their students could perform the specified behaviors, 88 percent indicated that one-half or more of their students could perform the

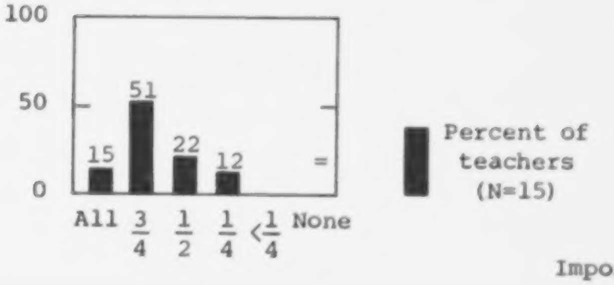


Figure 40. Proportion of students able to perform on subobjectives of objective 108

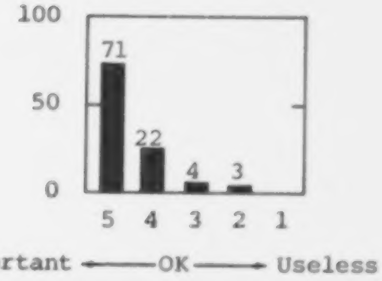


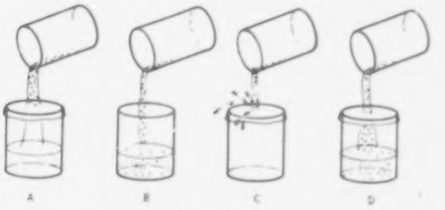
Figure 41. Importance of the subobjectives

specified behaviors. Figure 41 shows the very high importance rating given to these subobjectives by the teachers.

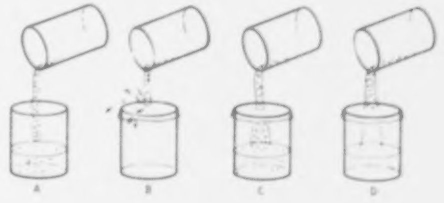
Three pairs of test items were designed to assess student achievement on this objective.

WHICH PICTURE SHOWS PIECES OF FOOD IN SOLUTION PASSING THROUGH A MEMBRANE?
MARK AN X ON THE CORRECT PICTURE.

15-A



WHICH PICTURE SHOWS PIECES OF FOOD IN SOLUTION PASSING THROUGH A MEMBRANE?
MARK AN X ON THE CORRECT PICTURE.



Item pair 15-A, 25-B provides baseline data for this objective and functions at the cognitive level of comprehension. This item pair gives a good clue concerning the ability of mentally handicapped students to relate a word description to specific pictures. Mean net gain from pretest to posttest was four percent (from 68 to 72 percent) for the control group. The biserial correlations on the posttest were higher

Table 60. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-15	79	4	11	9	76	0	0	87	13	15	2	70	0	0	.47	.57
	B-25	87	11	15	60	11	1	1	79	6	8	75	11	0	0	.43	.51
Control	A-15	80	11	9	10	70	0	0	88	6	14	14	66	1	0	.11	.43
	B-25	88	16	14	56	14	1	0	80	11	8	64	18	0	0	.36	.35

for the experimental group than for the control group, but the items were good discriminators in both groups. Little effect, if any at all, can be attributed to instruction on this item pair. Improving the artwork by using an opaque membrane may help improve this item pair.

Table 61. Pretest to Posttest Changes
(The response choice for A-15 is cited first.)

Item Pair A-15, B-25	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	C	D+C	A	D	A+D	B	A	B+A	C	B	C+B
Experi-mental	-6	+15	+4	+9	0	+4	+4	-5	0	-7	-7	-7
Control	-4	+8	+2	-5	+4	-1	+5	-5	0	+4	-6	-1

Item pair 19-A, 23-B provides baseline information for this objective and functions at the cognitive level of application. Mean net

WHICH WILL DISSOLVE IN WATER AND FORM
A SOLUTION?
MARK AN X ON YOUR CHOICE.

19-A

MARBLES	SALT	POPCORN	WOOD
A	B	C	D

WHICH WILL DISSOLVE IN WATER AND FORM
A SOLUTION?
MARK AN X ON YOUR CHOICE.

23-B

ROCKS	SALT	PEANUTS	PINS
A	B	C	D

Table 62. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	A-19	79	10	75	11	4	0	0	87	7	83	8	2	0	0	.52	.45
	B-23	87	7	72	11	8	1	0	79	1	86	9	4	0	0	.35	.50
Control	A-19	80	9	66	14	9	1	1	88	3	76	16	2	2	0	.30	.56
	B-23	88	8	73	14	3	2	0	80	4	81	9	5	1	0	.58	.51

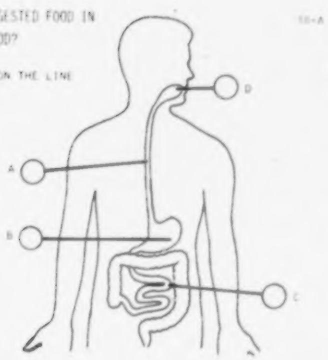
gain from pretest to posttest was 11 percent (from 73 to 84 percent) for the experimental group and eight percent (from 70 to 78 percent) for the control group. The biserial correlations were high for both groups, indicating that the items are good discriminators. These results indicate that no effect due to instruction is measured by this item pair. Prior student knowledge about the meaning of the word "dissolve," however, could enable the students to deduce the correct response without instruction. Teachers' comments suggest that higher gains would be achieved if the response choice were read to the students. This change should be made.

Table 63. Pretest to Posttest Changes
(The response choice for A-19 is cited first.)

Item Pair A-19, B-23	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	C	C+C	D	D	D+D
Experimental	+8	+14	+11	-3	-6	-4	-3	-2	-3	-2	-4	-3
Control	+10	+8	+8	-6	-4	-5	+2	-5	-1	-7	+2	-3

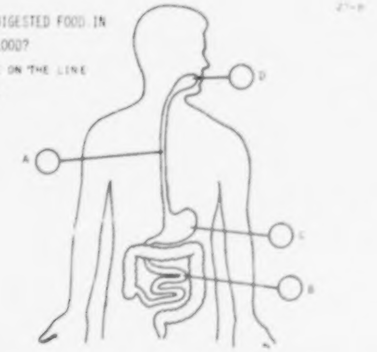
IN WHAT PART DOES THE DIGESTED FOOD IN SOLUTION GO INTO THE BLOOD?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



IN WHAT PART DOES THE DIGESTED FOOD IN SOLUTION GO INTO THE BLOOD?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



Item pair 30-A, 27-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 16 percent (from 49 to 65 percent). For the control group, this was two percent (from 51 to 53 percent). The gain for the experimental group can be accounted for by shifts from all distractors to the correct response. These results indicate that this item pair is measuring an effect attributable to instruction. The biserial correlations

Table 64. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	A-30	79	9	29	56	5	0	0	87	14	21	62	3	0	0	.32	.35
	B-27	87	24	43	26	6	0	1	79	6	68	23	1	1	0	.30	.55
Control	A-30	80	9	34	50	6	0	0	88	11	32	52	2	2	0	.31	.21
	B-27	88	11	52	30	6	1	0	80	14	54	28	5	0	0	.33	.27

Table 65. Pretest to Posttest Changes
(The response choice for A-30 is cited first.)

Item Pair A-30, B-27	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	A	A+A	B	C	B+C	D	D	D+D
Experi-mental	+6	+25	+16	+5	-18	-7	-8	-3	-5	-2	-5	-4
Control	+2	+2	+2	+2	+3	+2	-2	-2	-2	-4	-1	-3

indicate that the items are good discriminators. The instructions in the stem should be changed to "Mark an X on the line..."

Objective Achievement Tests

Descriptive Data and Interpretation. Pretests were administered to experimental classes between November 1 and 7, 1970 and to control classes between November 9 and December 4, 1970. Some minor corrections, mostly concerning colors, were made in the test slides between pretest and posttest administrations.

Differences in the amount of class time spent per activity and in the amount of time devoted to science instruction each week caused a wide difference in administration dates within the experimental group. The earliest was January 4, 1971 and the latest was March 1, 1971. Control group posttests were administered between January 7 and 20, 1971.

Raw score frequency distributions on the tests for both experimental and control groups are shown in Table 66. Tables 67 and 68 provide more detailed descriptive data on pretest and posttest scores and on residual gain scores, calculated by using the raw regression coefficient for the combined experimental and control classes. The interpretations that follow are based upon the data provided in these tables.

1. Students using Forms A and B in the experimental classes had similar pretest means, well within the standard error of measurement of the instruments.

Table 66. Frequency Distribution of Raw Scores for Test Forms A and B, Experimental and Control Groups

	Experimental Groups				Control Groups			
Raw Scores	Pre A	Post B	Pre B	Post A	Pre A	Post B	Pre B	Post A
30								
28-29		8		2				
26-27		9	1	7		2	1	
24-25	4	16		8	3	3	1	
22-23	3	9	2	17	5	3	1	5
20-21	7	10	8	25	5	9	7	10
18-19	18	12	14	9	10	13	21	16
16-17	19	7	17	4	21	17	15	
14-15	9	3	17	4	12	20	18	16
12-13	16	1	14	3	13	9	9	9
10-11	3	2	5	7	8	4	12	5
8-9		1	6		2		3	2
6-7		1	2	1	1			
4-5			1					1
2-3								
0-1								
Totals	79	79	87	87	80	80	88	88

2. Students using test Forms A and B in the experimental classes had similar posttest means. The unadjusted posttest means were well within the standard error of measurement of the instruments. Posttest reliabilities were above the minimum acceptable level of .70. Fourteen of 16 experimental classes showed positive mean residual gain scores. The negative mean residual gain scores were not seriously low. A multiple stepwise regression to determine the effects of independent variables on posttest scores was performed. Examination of the multiple regression output to

Table 67. Experimental Group Pretest, Posttest, and Residual Gain Data, March 1971
Unit I, *ME NOW*, Digestion and Circulation

	PRETEST						POSTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range
																	Min.	Max.
Form A 21	5	17.20	57.33	3.70		1.66	11-21	19.40	64.67	8.20		3.67	6-28	-0.23	5.55	2.48	- 9.09	5.59
22	13	14.85	49.50	2.34		0.65	12-19	18.00	60.00	4.24		1.18	10-24	0.09	4.49	1.25	- 7.29	5.98
23	12	15.75	52.50	2.63		0.76	12-19	22.00	73.33	3.95		1.14	16-29	3.43	3.15	0.91	- 0.75	8.79
24	10	14.30	47.67	2.06		0.65	12-17	18.70	62.33	4.88		1.54	9-25	1.19	4.88	1.54	- 6.82	8.18
25	11	17.18	57.27	2.52		0.76	12-20	23.64	78.80	2.84		0.86	18-28	4.02	2.75	0.83	0.05	9.25
26	10	21.50	71.67	2.88		0.91	16-25	26.30	87.67	2.21		0.70	21-28	3.52	2.31	0.73	- 0.68	7.05
27	10	16.10	53.67	3.87		1.22	10-23	21.20	70.67	5.05		1.60	11-27	2.38	3.64	1.15	- 3.48	7.71
28	8	16.63	55.43	4.21		1.49	12-24	23.13	77.10	3.68		1.30	18-29	3.92	3.57	1.26	- 0.95	9.18
All A	79	16.57	55.23	3.55	0.57	2.28*	10-25	21.54	71.80	4.92	0.81	2.12*	6-29	2.38	3.94	0.44	- 9.09	9.25
Form B 31	6	14.50	48.33	4.97		2.03	6-20	20.67	68.90	5.35		2.19	10-24	3.01	3.25	1.33	- 1.43	6.71
32	11	13.09	43.63	3.94		1.19	5-19	15.73	52.43	7.39		2.23	1-26	-0.89	5.71	1.72	-14.09	6.18
33	10	16.70	55.67	3.02		0.96	12-22	22.50	75.00	2.64		0.83	19-27	3.24	2.56	0.81	- 0.22	7.52
34	10	17.40	58.00	3.41		1.08	9-21	21.20	70.67	2.35		0.74	17-25	1.42	2.21	0.70	- 2.41	4.25
35	10	13.00	43.33	2.05		0.65	9-16	18.00	60.00	3.23		1.02	11-22	1.45	2.80	0.88	- 2.62	5.45
36	11	16.18	53.93	4.29		1.29	7-22	21.45	71.50	5.01		1.51	11-28	2.57	2.85	0.86	- 2.22	6.79
37	15	14.73	49.10	4.64		1.20	8-26	20.40	68.00	5.10		1.32	11-28	2.58	3.66	0.94	- 5.55	10.11
38	14	15.00	50.00	3.49		0.93	8-20	20.07	66.90	4.27		1.14	11-26	2.05	3.42	0.91	- 4.82	7.38
All B	87	15.07	50.23	3.93	0.62	2.38*	5-26	19.97	66.57	4.93	0.76	2.18*	1-28	1.90	3.58	0.38	-14.09	10.11
All	166	15.78	52.60	3.82		0.30	5-26	20.72	69.07	4.97		0.39	1-29	2.13	3.75	0.29	-14.09	10.11
Boys	112	16.42	54.73	3.65		0.35	8-26	21.54	71.80	4.10		0.39	6-29	2.48	3.22	0.30	- 9.09	10.11
Girls	54	14.46	48.20	3.84		0.52	5-25	19.02	63.40	6.12		0.83	1-29	1.39	4.62	0.63	-14.09	8.79

*Standard error of estimate (σ_s) for individual scores.

Table 68. Control Group Pretest, Posttest, and Residual Gain Data, March 1971 Unit I, *ME NOW*, Digestion and Circulation

	PRETEST							POSTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range	
																	Min.	Max.
Form A 81	11	13.00	43.33	2.32		0.70	9-17	13.91	46.37	2.74		0.83	11-21	-2.64	2.29	0.69	- 5.55	2.98
82	7	14.29	47.63	2.36		0.89	10-17	15.29	50.97	2.81		1.06	10-18	-2.21	3.01	1.14	- 7.29	1.45
83	11	14.09	46.97	3.27		0.99	10-20	16.36	54.53	2.58		0.78	12-21	-0.99	2.57	0.77	- 4.22	4.45
84	12	21.75	72.50	1.96		0.57	19-25	22.58	75.27	2.71		0.78	17-26	-0.38	2.22	0.64	- 4.34	2.59
85	8	16.38	54.60	2.72		0.96	12-20	16.50	55.00	2.45		0.87	11-19	-2.52	2.05	0.73	- 4.82	1.45
86	9	14.67	48.90	5.24		1.75	7-24	16.33	54.43	2.35		0.78	13-20	-1.44	3.70	1.23	- 9.61	2.84
87	11	14.91	49.70	2.21		0.67	12-19	15.27	50.90	2.41		0.73	13-21	-2.68	1.93	0.58	- 5.48	1.52
88	11	16.00	53.33	2.41		0.73	10-19	16.73	55.77	2.61		0.79	13-21	-2.02	2.81	0.85	- 6.48	1.71
All A	80	15.78	52.60	3.89	0.62	2.35*	7-25	16.78	55.93	3.60	0.57	2.32*	10-26	-1.81	2.61	0.29	- 9.61	4.45
Form B 91	12	13.92	46.40	2.31		0.67	11-18	15.67	52.23	3.23		0.93	10-20	-1.56	2.45	0.71	- 7.29	1.45
92	9	15.78	52.60	4.18		1.39	8-20	17.78	59.27	3.67		1.22	12-23	-0.81	1.91	0.64	- 3.09	2.05
93	12	14.25	47.50	3.11		0.90	10-19	16.08	53.60	3.82		1.10	8-23	-1.39	3.77	1.09	-10.02	3.71
94	9	13.44	44.80	4.03		1.34	8-19	14.11	47.03	2.20		0.73	10-17	-2.77	2.83	0.94	- 6.22	1.64
95	7	17.86	59.53	2.48		0.94	15-23	15.57	51.90	4.93		1.86	5-20	-4.54	3.93	1.49	-13.02	-1.48
96	10	16.20	54.00	3.22		1.02	12-21	16.20	54.00	2.66		0.84	13-20	-2.70	3.13	0.99	- 8.41	1.71
97	14	16.50	55.00	3.01		0.80	10-20	17.93	59.77	2.95		0.79	13-23	-1.19	2.11	0.56	- 4.75	2.05
98	15	17.53	58.43	4.24		1.09	11-26	15.53	51.77	3.74		0.97	9-21	-4.34	2.33	0.60	- 7.48	-0.29
All B	88	15.70	52.33	3.62	0.56	2.36*	8-26	16.17	53.90	3.48	0.57	2.26*	5-23	-2.36	3.01	0.32	-13.02	3.71
All	168	15.74	52.47	3.74		0.29	7-26	16.46	54.87	3.54		0.26	5-26	-2.10	2.83	0.22	-13.02	4.45
Boys	101	15.89	52.97	3.68		0.37	7-26	16.42	54.73	3.49		0.35	5-26	-2.25	2.80	0.23	-13.02	2.98
Girls	67	15.51	51.70	3.84		0.47	8-25	16.52	55.07	3.65		0.45	8-26	-1.87	2.87	0.35	-10.02	4.45

*Standard error of estimate (σ_s) for individual scores.

determine the most influential variable(s) was followed by an analysis of covariance to determine if there were significant differences between classes on posttest scores, with the pretest score held as a covariate. An analysis of variances on residual gain scores was also performed to confirm the results of the analysis of covariance.

3. Students using Forms A and B in the control classes had similar pretest means, well within the standard error of measurement of the instruments. The control group posttest scores, as well as the pretest-to-posttest gain, were all within the standard error of measurement. The control group classes, then, did not change their performance from pretesting to posttesting. A one-way analysis of variance was computed on residual gain scores to determine if a significant difference existed between the experimental and control groups.

Multiple Stepwise Regression Analysis

Experimental Group, Unit I. To determine the effect on posttest scores, if any, of the independent variables, the following question was investigated: "Is there a significant difference in the level of achievement on the posttest among students in EMH classes having different background variables?"

The following independent variables were used to test this question: sex, age, WISC Full Scale IQ, race, teacher's assessment of reading achievement, teacher's assessment of verbal participation, time elapsed between pretest and posttest, and pretest score. Since

Forms A and B are parallel forms, all student scores were pooled and treated as the results of one test.

The test statistic used in testing the question is the F-statistic generated for each independent variable in the last step of the multiple stepwise regression:

$$F_{\alpha(\nu_1,\ \nu_2)} = \left(\frac{\beta_i}{S\beta_i}\right)^2$$

where β_i represents the weight of the independent variable (slope of the regression line).

$S\beta_i$ represents the standard error of the weight of the independent variable.

The results for the posttest administered to the 166 students in the Unit I experimental group are summarized in Table 69.

Table 69. Results of Multiple Linear Regression Analysis, Experimental Group, Unit I. N = 166

Independent Variable	β_i	$S\beta_i$	F
Sex	-0.6619	0.6130	1.1659
Age	0.0464	0.0194	5.7548*
WISC Total IQ	0.1205	0.0365	10.9084**
Race	-0.0483	0.4525	0.0114
Reading Achievement	0.2563	0.2398	1.1426
Verbal Participation	0.3729	0.2558	2.1247
Pretest	0.6576	0.0833	62.3910**
Time	0.1636	0.1457	1.2612

*Significant at the .025 level, $F_{.025(1,157)} = 5.02$

**Significant at the .001 level, $F_{.001(1,157)} = 10.83$

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the posttest instrument.

Discussion

The data indicate that sex, race, teacher's assessment of reading achievement and verbal participation, and time elapsed between administration of pretest and posttest are not significant predictors of success on the posttest. The pretest and WISC Total IQ, however, are highly significant predictors of success on the posttest ($P<.001$). Age is also a significant predictor of success on the posttest ($P>.025$). These results indicate that prior knowledge of the concepts measured by the test instrument and WISC Full Scale scores were the best determinants of whether or not the experimental group students attained high scores on the posttest. Test analysis shows that 13 of the 30 items were aimed at baseline information and that 16 of the 30 items involved cognitive levels higher than factual recall. With 43 percent of the items aimed at baseline information, the high predictive value of the pretest is not surprising. In the Spring, 1970 testing, the pretest was also a significant predictor of success ($P<.01$), but age and WISC Full Scale IQ were not. The inclusion of age and WISC Full Scale IQ as significant predictors of posttest scores on the 1970-71 test instruments can probably be accounted for by the fact that 16 of the 30 items involve higher cognitive levels. It seems reasonable to assume that the more intelligent and/or slightly older students would be able to function better at these higher cognitive levels than less intelligent and/or younger students. An analysis of variance based on a 3x3 factorial design was performed on residual gain scores to investigate this inference.

Table 70. Matrix of Correlation Coefficients
Experimental Group, Unit I

	Age	Total IQ	Race	Reading Achievement	Verbal Participation	Pretest	Time	Posttest
Sex	-.138	1.166	-.062	.080	-.040	-.241	.018	-.238
Age		-.049	-.171	.271	.092	.250	-.210	.287
Total IQ			-.066	.294	.307	.411	-.133	.469
Race				-.118	-.176	-.047	.455	-.063
Reading Achievement					.387	.168	-.141	.279
Verbal Participation						.080	-.163	.230
Pretest							-.023	.665
Time								-.032

Table 71. Multiple Stepwise Regression Analysis
Experimental Group, Unit I

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables
1	Pretest	.6649	.4421	.4421	129.9423	1
2	Total IQ	.6989	.4884	.0464	14.7708	2
3	Age	.7178	.5153	.0269	8.9790	3
4	Verbal Participation	.7244	.5247	.0094	3.1828	4
5	Time	.7272	.5288	.0041	1.3900	5
6	Sex	.7288	.5311	.0023	0.7883	6
7	Reading Achievement	.7311	.5345	.0034	1.1467	7
8	Race	.7311	.5345	.0000	0.0114	8

The effect of the pretest accounts for approximately 44.2 percent of the variance in the regression equation. This datum is determined by the multiple r^2 in Table 71. With the 16-item instrument used during the Spring, 1970 testing of Unit I, the pretest accounted for only 23.6 percent of the variance in the regression equation. The change from 23.6 to 44.2 percent of the variance being accounted for by the pretest is a significant improvement.

The combination of pretest and WISC Total IQ as an independent or predictor variable accounts for 48.8 percent of the variance, and the combination of pretest, WISC Total IQ, and age accounts for 51.5 percent. The inclusion of all eight independent variables accounts for 53.5 percent of the variance in the regression equation. This is a significant improvement when compared to the 30.6 percent of the variance accounted for by the effect of the six independent variables in the regression equation of the Spring, 1970 testing.

Information and experience acquired by the BSCS staff in the initial testing and evaluation of Unit I have proven extremely valuable in revising old items and writing new items for the current testing period, as demonstrated by the higher reliability and biserial calculations.

As was indicated in the Spring, 1970 evaluation of *ME NOW*, student-student and student-teacher interactions are very important variables that need to be investigated. Unfortunately, sufficient funds are not available for videotape equipment or for personnel trained in interaction protocol to gather the necessary data.

Objective Achievement Tests

Analyses of Variance and Covariance, Experimental Group, Unit I. Two statistical tests were performed to investigate the question, "Is there a significant difference between experimental classes in the level of achievement on the Unit I posttest?" The results of an analysis of covariance are summarized in Table 72 and indicate no significant difference between classes on posttest means adjusted for differences in pretest scores. Table 73 summarizes the means and standard deviations for pretest and posttests for each class in the experimental group.

Table 72. Analysis of Covariance between Classes on Adjusted Unit I Posttest Means, Pretest as Covariate

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	19.2449	1.4419
Within Groups	164	13.8860	

$F_{.05(15,164)}$ = 1.67, no significant difference

Table 73. N, Means, Standard Deviations and Adjusted Means of 16 Classes, Experimental Group, Unit I

Class Number	N	Posttest Mean	Posttest Standard Deviations	Adjusted Posttest Mean	Pretest Mean
21	5	19.40	8.20	18.30	17.20
22	13	18.00	4.24	18.73	14.85
23	12	22.00	3.95	22.03	15.75
24	10	18.70	4.88	19.86	14.30
25	11	23.64	2.84	22.55	17.18
26	10	26.30	2.21	21.85	21.50
27	10	21.20	5.05	20.95	16.10
28	8	23.13	3.68	22.47	16.63
31	6	10.67	5.35	21.67	14.50
32	11	15.73	7.39	17.82	13.09
33	10	22.50	2.64	21.79	16.70
34	10	21.20	2.35	19.94	17.40
35	10	18.00	3.23	20.17	13.00
36	11	21.45	5.00	21.14	16.18
37	15	20.40	5.10	21.22	14.73
38	14	20.07	4.27	20.68	15.00

Since the effect of a regression to the posttest mean could have influenced the results of the analysis of covariance, an analysis of variance was computed between experimental classes with residual gain scores as the dependent variable. The residual gain score minimizes the effect of the regression to the posttest mean that is inherent in a pretest-posttest design. Residual gain is defined as the difference between a predicted score ($Y' = a + bX$) and the actual score (Y) on the posttest, or $Y-Y'$, where:

Y' = predicted posttest score

a = Y intercept of the regression line (constant)

b = slope of the regression line (the within-class pooled regression coefficient, in this case)

X = actual pretest score

Y = actual posttest score[17]

The within-class pooled regression coefficient was used in this computation instead of the raw regression coefficient to preserve the teacher effect. These are not the same residual gain scores reported in Table 67. Table 74 shows the results of the analysis of variance,

Table 74. Analysis of Variance between Classes on Residual Gain Scores, Experimental Group, Unit I

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	20.4654	1.5437
Within Groups	150	13.2576	

$F_{.05(15,150)} = 1.67$ no significant difference indicating no significant difference between classes on residual gain scores. This is the same result that was obtained with the reduced, 16-item test during the Spring, 1970 testing. Table 75 summarizes the means and standard deviations for residual gain scores for each class in the experimental group.

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[17] Kenneth D. Hopkins. "Regression and the Matching Fallacy in Quasi-Experimental Research," Jrnl. of Special Education, 3(1):329-36 (1969).

Table 75. Residual Gain, Class Data
Experimental Group, Unit I

Class Number	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
21	5	-2.40	5.39	2.41	3.24	-10.97	14.21
22	13	-1.97	4.53	1.26	3.91	- 9.31	13.22
23	12	1.33	3.13	0.90	6.58	- 2.87	9.45
24	10	-0.84	4.89	1.55	6.25	- 8.75	15.00
25	11	1.85	2.78	0.84	7.13	- 2.20	9.33
26	10	1.15	2.38	0.75	4.80	- 2.98	7.78
27	10	0.26	3.61	1.14	5.69	- 5.65	11.34
28	8	1.77	3.65	1.29	7.25	- 3.20	10.45
31	6	0.97	3.21	1.31	4.69	- 3.08	7.77
32	11	-2.87	5.63	1.70	4.25	-15.97	20.22
33	10	1.09	2.62	0.83	5.36	- 2.42	7.78
34	10	-0.76	2.26	0.72	2.13	- 4.76	6.89
35	10	-0.53	2.80	0.88	3.47	- 4.41	7.88
36	11	0.45	2.77	0.84	4.58	- 4.42	9.00
37	15	0.52	3.65	0.94	8.37	- 7.53	15.90
38	14	-0.02	3.42	0.91	5.59	- 6.75	12.34

Factorial Analyses, Experimental Group. The results of the multiple linear regression on the posttest indicated that age and IQ were significant predictors of success on the posttest ($P<.001$). To further investigate this result and to minimize the effect of the regression to the posttest mean, the following question was investigated:

"Is there a significant difference in residual gain scores between students blocked on three ranges of age and three ranges of WISC Verbal IQ scores?"

To answer this question, residual gain scores for the 116 students with WISC Verbal IQ data were blocked on three different ranges of age: ≤137 months, 138 to 155 months, and ≥156 months; and on three ranges of WISC Verbal IQ scores: ≤66, 67 to 79, and ≥80. An analysis of variance was performed on the residual gain scores in this 3x3 factorial design. Table 76 contains the results of the analysis of variance, indicating no significant difference between the three blocks of ages, a significant difference between the three blocks of IQ scores, and no significant interaction effects. A significance level with a P greater than .05 is considered not to be significant. Table 77 summarizes the N, means and standard deviations for the residual gain scores by cells, rows and columns.

Table 76. ANOVA, Residual Gain Blocked on Verbal IQ and Age, Experimental Group, Unit I

Source	d.f.	Hypothesis Mean Square	F	Significance Level
Between Age Groups	2	15.5359	1.4908	P<.2299
Between IQ Groups	2	73.8285	7.0847	P<.0013
Interaction	4	20.4430	1.9617	P<.1056
Within Groups	107	10.4209		

To determine the effect of age and WISC Performance IQ scores on residual gain scores, the following question was investigated: "Is there a significant difference in residual gain scores between students blocked on three ranges of age and three ranges of WISC Performance IQ scores?"

To answer this question, residual gain scores for the 116 students with WISC Performance IQ data were blocked on the same three ranges of age (≤137 months, 138 to 155 months, and ≥156 months) and WISC Performance IQ scores (≤66, 67 to 79, and ≥80). An analysis of variance was performed on the residual gain scores in this 3x3 factorial design. As summarized in Table 78, the results of the analyses of variance indicate no significant differences between the three blocks of ages, or the three blocks of IQ scores, and no significant inter-

Table 77. N, Mean Residual Gain Scores & Standard Deviations by Cells, Age and WISC Verbal IQ, Experimental Group, Unit I

Age Levels	WISC Verbal IQ Levels			Σ Rows
	≤66	67-79	≥80	
≤137 months	N = 8 M = -3.0447 SD = 3.8837	N = 17 M = 0.7127 SD = 4.3208	N = 18 M = -0.5216 SD = 3.1016	N = 43 M = -0.5031
138-155 months	N = 8 M = -3.3354 SD = 4.8265	N = 25 M = 1.3066 SD = 2.7876	N = 15 M = 1.5697 SD = 2.2374	N = 48 M = 0.6152
≥156 months	N = 8 M = -0.2540 SD = 2.1790	N = 12 M = -0.0714 SD = 2.5640	N = 5 M = -0.8473 SD = 2.3453	N = 25 M = -0.2850
Σ Columns	N = 24 M = -2.2110	N = 54 M = 0.8134	N = 38 M = 0.2611	

Table 78. ANOVA, Residual Gain Blocked on Performance IQ and Age Experimental Group, Unit I

Source	d.f.	Hypothesis Mean Square	F	Significance Level
Between Age Groups	2	15.5359	1.3531	P<.2629
Between IQ Groups	2	30.7427	2.6776	P<.0734
Interaction	4	13.6133	1.1857	P<.3214
Within Groups	107	11.4815		

action effects. Table 79 summarizes the N, means and standard deviations for the residual gain scores by cells, rows and columns.

To determine the effect of age and WISC Full Scale IQ scores on residual gain scores, the following question was investigated: "Is there a significant difference in residual gain scores between students blocked on three ranges of age and three ranges of WISC Full Scale IQ scores?"

To answer this question, residual gain scores for the 166 students with WISC Full Scale IQ data were blocked on the same three ranges of age (≤137 months, 138 to 155 months, ≥156 months) and WISC Full Scale IQ scores (≤66, 67 to 79, and ≥80). An analysis of variance was performed on the residual gain scores in the 3x3 factorial design. In

Table 79. N, Mean Residual Gain Scores & Standard Deviations by Cells, Age and WISC Performance IQ, Experimental Group, Unit I

Age Levels	WISC Numerical IQ Levels			
	≤66	67-79	≥80	Σ Rows
≤137 months	N = 8 M = -0.2904 SD = 4.7058	N = 18 M = -1.1444 SD = 4.1960	N = 17 M = 0.0759 SD = 3.3246	N = 43 M = -0.5031
138-155 months	N = 13 M = -1.6504 SD = 4.3872	N = 18 M = 1.2452 SD = 3.2349	N = 17 M = 1.6806 SD = 2.0629	N = 48 M = 0.6152
≥156 months	N = 5 M = 1.3962 SD = 1.1926	N = 9 M = 0.3046 SD = 2.4003	N = 11 M = -0.2623	N = 25 M = 0.2850
Σ Columns	N = 26 M = -1.1830	N = 45 M = 0.1012	N = 45 M = 0.5994	

Table 80 the results of the analysis of variance indicate no significant differences between the three blocks of ages, a significant (P<.0041) difference between the three blocks of IQ scores, and no significant interaction effects. Table 81 summarizes the N, means and standard deviations for the residual gain scores by cells, rows and columns.

Table 80. ANOVA, Residual Gain Blocked on WISC Full Scale IQ and Age, Experimental Group, Unit I

Source	d.f.	Hypothesis Mean Square	F	Significance Level
Between Age Groups	2	33.0996	2.5189	P<.0839
Between IQ Groups	2	75.1098	5.7158	P<.0041
Interaction	4	4.0281	0.3065	P<.8733
Within Groups	157	13.1407		

Table 81. N, Mean Residual Gain Scores and Standard Deviations by Cells, Age and WISC Full Scale IQ, Experimental Group, Unit I

Age Levels	WISC Full Scale IQ Levels			Σ Rows
	≤66	67-79	≥80	
≤137 months	N = 10 M = -2.3509 SD = 5.3415	N = 35 M = -0.5371 SD = 4.6948	N = 12 M = -0.4153 SD = 2.9554	N = 57 M = -0.8296
138-155 months	N = 18 M = -1.6844 SD = 3.9351	N = 43 M = 1.3539 SD = 3.0296	N = 12 M = 1.2697 SD = 1.7865	N = 73 M = 0.5909
≥156 months	N = 10 M = -0.7741 SD = 2.4176	N = 21 M = 0.4862 SD = 2.9044	N = 5 M = 0.9969 SD = 3.7306	N = 36 M = 0.2071
Σ Columns	N = 38 M = -1.6200	N = 99 M = 0.5013	N = 29 M = 0.5254	

Discussion

The analyses of variance were made in a 3x3 factorial design with residual gain scores blocked in low, middle and high ranges of WISC Verbal, Performance and Full Scale IQ scores and on three age ranges. The results indicate that there is no significant difference between the three age groups when the residual gain score is the dependent variable. In the light of this result, the fact that age was a significant predictor of posttest scores ($P<.025$) is probably attributable in part to the effect of a regression to the posttest mean.

There was no significant difference between the three groups of students in low, middle and high ranges of WISC Performance IQ scores. We concluded from this result that the effect of WISC Performance IQ on posttest success has been minimized. Although many psychomotor and eye-hand coordination skills are employed throughout Unit I, students with low WISC Performance IQ scores seemed to achieve as well as students with high WISC Performance IQ scores. Also, no significant interaction effects were detected between age and Verbal, Performance or Full Scale IQ.

The result of the analysis of variance, with residual gain scores blocked on age and Verbal IQ scores, indicates a significant difference between students in the low, middle and high IQ groups. An examination of the mean scores indicates that the middle and high IQ groups are achieving higher residual gain scores than the low IQ group. (Since *ME NOW* materials stress verbal interaction among students and between students and the teacher, this result is not surprising.) In view of this result, it would seem that the *ME NOW* materials as presently constituted are best suited for students with WISC Verbal IQ scores above 66.

Limited subjective data based on classroom visits by BSCS staff members indicate that many teachers are not involving their slower students in classroom discussions. This observation may be valid or could be a result of the teachers' involving mainly verbal students to "look good" for visiting personnel. Special efforts will have to be made by BSCS personnel to suggest ways in which teachers can involve students with low Verbal IQ scores. This should be a major goal of the team revising the Unit I materials.

The results of the analysis of variance with residual gain scores blocked on age and WISC Full Scale IQ scores indicates a significant difference between students in the low, middle and high IQ groups. An examination of mean residual gain scores reveals that the middle and high IQ groups are achieving higher success than students in the low group. This result indicates that the *ME NOW* materials are successful with a large part of the EMH population, ages 11 to 13, but teachers will need to provide additional help and stimuli to students in the low IQ ranges. Again, BSCS personnel should include suggestions for the teacher in the revised Teacher's Guide on how to overcome this problem.

Experimental-Control Group Analyses. To investigate the question, "Is there a significant difference between the experimental and control groups in the residual gain scores?" these scores were calculated using the raw regression coefficient, obtained by pooling all experimental and control students, and an analysis of variance was performed on the residual gain scores between the two groups. Table 82 summarizes the mean residual gain scores and standard deviations for both groups.

Table 83 summarizes the results of the analysis of variance, indicating a significant ($P<.001$) difference between the experimental and control groups.

Table 82. Residual Gain Means and Standard Deviations Experimental and Control Groups, Unit I

Group	N	Mean	Standard Deviations
Experimental	166	2.1254	3.7501
Control	168	-2.1002	2.8280

Table 83. ANOVA, Experimental and Control Residual Gain Scores, Unit I

Source	d.f.	Mean Square	F-Ratio
Between groups	1	1490.8623	135.3835**
Within groups	332	11.0121	

**$F_{.001(1,332)}$ = 10.83, significant at the .001 level

Discussion

The results of the analysis of variance indicated that there was a significant difference (P<.001) between the experimental and control groups on residual gain scores. We therefore concluded that the experimental Unit I materials did have an effect on EMH students as assessed by the objective tests. All 30 items assessed key objectives in Unit I, 13 were judged to measure baseline information, and 17 were considered to be good indicators of student growth from pretest to posttest.

Factor Analysis. To determine the structure of the Unit I achievement tests, a Harris-Kaiser oblique, unnormalized, orthogonal rotation was performed on the results of posttests A and B. For posttest A, 18 factors were identified which accounted for 54 percent of the variance. For posttest B, 18 factors were identified which accounted for 55 percent of the variance.

Table 84 presents the results for posttest A showing only those factors with eigenvalues above 1. The objective measured and cognitive level of each item is included, as is a hypothetical name for each factor. The cognitive levels identified are knowledge, low (comprehension, application), and high (analysis, synthesis, evaluation.)[18] Table 85 presents the results for posttest B, showing only those factors with eigenvalues above 1.

Table 84. Factor Structure - Unit I, Posttest A

Factor	Items	Cognitive Level	Objective	Name
1	21	High	100	food-blood sugar
	28	Low	107	relationships
2	10	Low	100	heartbeat-pulse
	25	High	100	relationships
3	6	Knowledge	105	sugar test-digestion
	17	Knowledge	104	
4	2	Knowledge	106	heartbeat-pulse
	7	Low	106	relationships
5	8	Knowledge	101	food-stomach action
	9	High	105	
6	4	Low	100	graphing-functions
	5	Knowledge	103	of mouth parts
	10	Low	100	
	24	Low	103	
	2	Knowledge	106	

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[18] Benjamin S. Bloom (Editor). Taxonomy of Educational Objectives Handbook I: Cognitive Domain, New York: David McKay Company, Inc. 1956.

Table 85. Factor Structure - Unit I, Posttest B

Factor	Items	Cognitive Level	Objective	Name
1	10	High	100	food-blood relationships
	13	Knowledge	106	
2	2	Knowledge	101	food-functions of mouth parts
	17	Low	103	
	28	High	106	
3	3	Low	106	heartbeat-pulse relationships
	28	High	106	
4	4	Low	103	digestive processes
	30	Low	105	
5	25	Low	108	digestion-diffusion
	29	Low	107	
	9	Knowledge	103	

Items 10 and 25 from posttest A and the parallel items, 3 and 28 from posttest B, appeared in both factor analyses as a single factor. Both pairs of items deal with heartbeat-pulse relationships. In general, items loading on the six factors of posttest A with eigenvalues above 1 and on the five factors of posttest B with eigenvalues above 1 were well distributed across the test. Items loading on individual factors were generally measuring identical or related instructional objectives.

Summary

We can safely conclude that students using Unit I of *ME NOW* learn from the use of these materials. Students with WISC Full Scale IQ scores of 66 and higher tend to perform better on achievement tests than students with lower scores. Achievement test results have identified some instructional problems and problems with items themselves that have resulted in modifications in both the instructional material and the test items. Teacher feedback indicates a high degree of student interest and motivation and has also helped identify some problems that have brought about revisions of the materials.

CHAPTER III

EVALUATION OF UNIT II

RESPIRATION AND EXCRETION

The Instructional Program

In the experimental classes, pretests for Unit II were administered and instruction was initiated between January 5 and March 2, 1971. The posttests were administered from February 1 to March 31, 1971. The total mean time in class devoted to this unit of *ME NOW* during the instructional period for the 16 classes was 557 minutes (9.3 hours).

Unit II is focused on the role of respiration and the fate of undigested food in "Me Now." In keeping with the philosophy of beginning with external and concrete evidence and proceeding to internal, more abstract and inferred data, this unit begins with observations of chest expansion during breathing. By holding paper bags over their mouths while breathing, students can infer that air is moving in and out of their chests and then verify this through the use of an artificial model.

The necessity of air for energy release is established by burning candels in open and closed containers and by using slides which portray mice in open and sealed compartments. Oxygen and carbon dioxide, the major components of the air involved in respiration are identified by student investigations. Quantitative measures of the relative amounts of oxygen and carbon dioxide in inhaled and exhaled air are made which help the students understand that more oxygen is taken into the body than is given off, and that more carbon dioxide is given off than is taken into the body. The danger of suffocation in abandoned refrigerators and plastic bags is portrayed through the use of newspaper articles.

Attention is then shifted to the relationship between muscle activity, breathing rates and a need for energy. Energy from wind, fuel, food, etc. is studied, and the need for food and oxygen in performing body activities is established. Attention is focused again on the circulatory system as a means for distributing food and oxygen to the muscles where they are used in energy production. Waste products of food "burning" and "excess water" are studied, and the fate of undigested food in the intestines is reviewed. The role of the urinary system in removing metabolic wastes and excess water is established and investigated through the use of an artificial model. This series of activities is completed with a study of perspiration followed by a review of the major points in Units I and II.

Effectiveness of Instruction: Data, Analysis and Interpretation

Objective 200. Students will infer that breathing is a necessary life process. To achieve this objective six student activities with related instructional strategies were designed to develop student competencies. For activities 1 and 2, 75 percent of the teachers reported they used the strategies as prescribed; 25 percent reported some modifications; 97 percent of the teachers reported that the strategies were successful. One teacher reported difficulties because she did not know where the diaphragm is located. An excellent modification was developed by one teacher: "We followed the context -- but went a step further. In the string-chest experiments we used a longer string and marked it with a felt pen at the spot [indicating] normal chest [diameter]. Then as I held the string, the model breathed deeply and we watched the string 'grow.' We noted the inches -- then we did the chalkboard list -- we noted that the chalk mark on the board corresponded in length with the expansion [string] measurements."

Figure 42 shows that teachers found student reactions to be very high across the three rating scales. Both activities were very important for EMH students (see Figure 43).

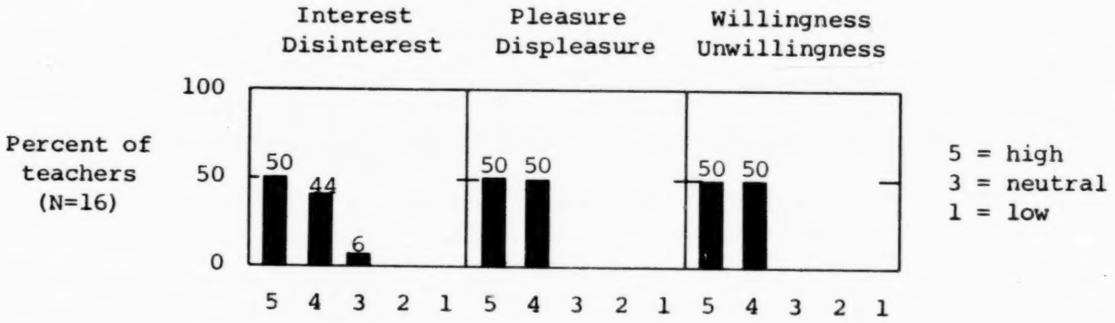


Figure 42. Reaction of the majority of students to activities 1 and 2

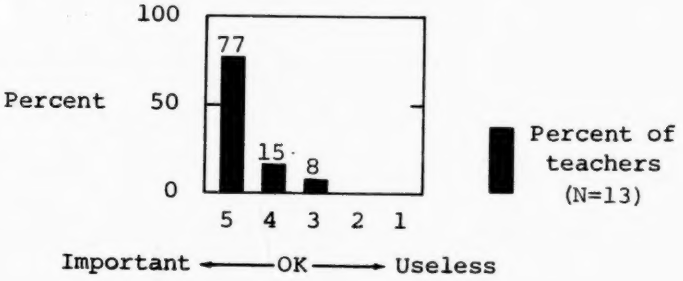


Figure 43. Importance to students of activities 1 and 2

Figure 44 shows the proportion of students who were able to perform the behaviors specified by the subobjectives for activities 1 and 2. Figure 45 shows that teachers rated the subobjectives as being very important for EMH students.

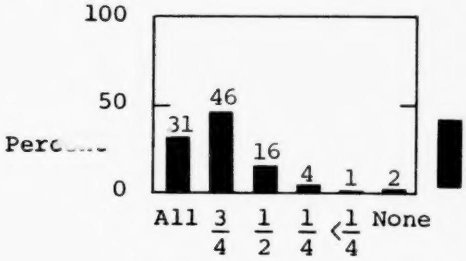


Figure 44. Proportion of students able to perform on subobjectives for activities 1 and 2

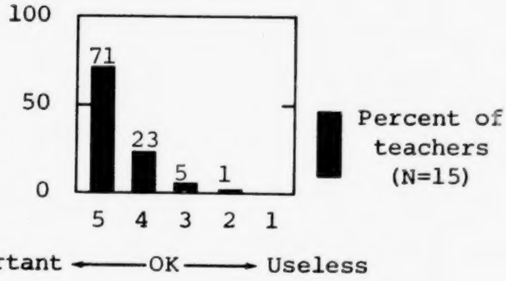


Figure 45. Importance of the subobjectives

For activities 3 and 4, 56 percent of the teachers reported using the strategies as prescribed; 31 percent reported some modification; six percent reported much modification; and six percent replaced the strategies. Sixty-nine percent of the teachers reported that the strategies were successful, while 19 percent reported that the strategies were unsuccessful.

Several serious problems were encountered in activity 4 that led to the low ratings. First, students were asked to record the time interval from beginning the oxygen test experiment to the time when the methylene blue solution turned color. Most students encountered difficulties measuring and recording time intervals. Some teachers changed the strategies and had the students count and record the number of breaths required to change the color of the methylene blue, and this was successful. The final materials were revised to include this change. Second, most of the methylene blue solutions, which had been prepared several weeks ahead of time, had broken down and would not change color. Those teachers who mixed a fresh supply of methylene blue reported that experiment successful. The Teacher's Guide was revised to have the teachers prepare the methylene blue solution just before the class begins.

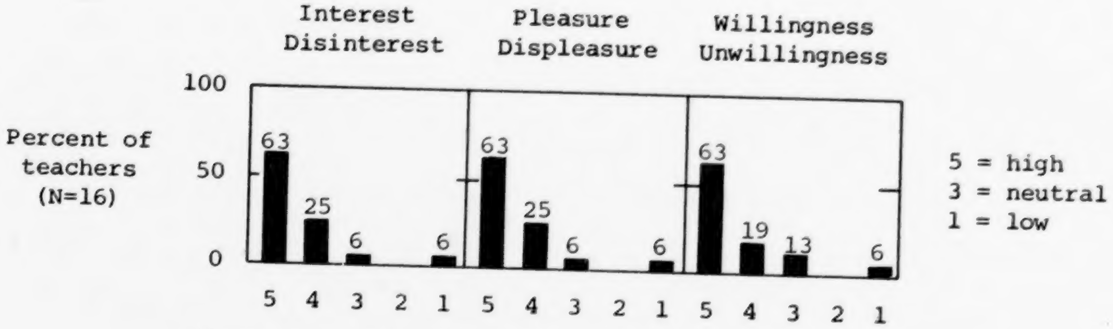


Figure 46. Reaction of the majority of students to activities 3 and 4

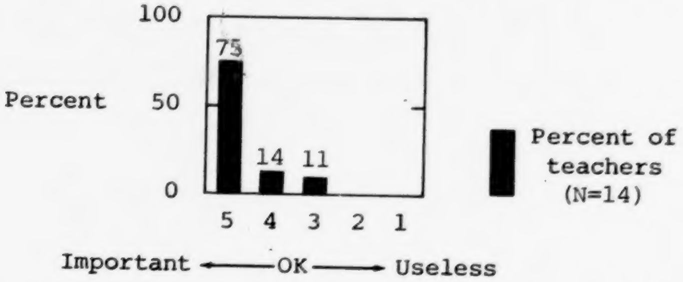


Figure 47. Importance to students of activities 3 and 4

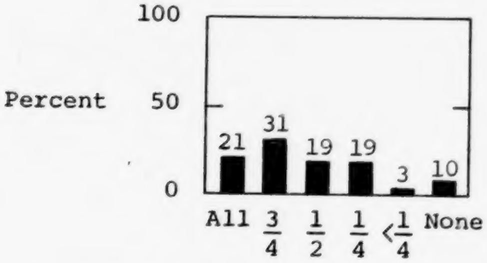


Figure 48. Proportion of students able to perform on subobjectives for activities 3 and 4

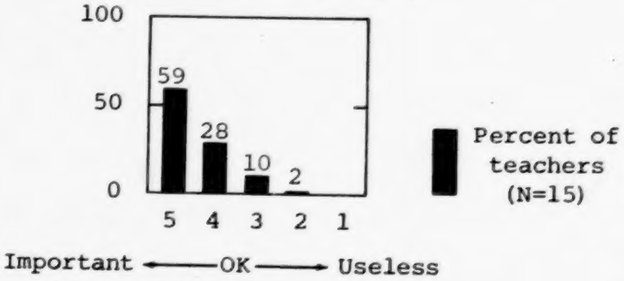


Figure 49. Importance of the subobjectives

Figure 46 shows student reactions to be very high across the three rating scales, in spite of the difficulties encountered. Both activities were important for EMH students (see Figure 47).

Figure 48 shows the proportion of students who were able to perform the behaviors specified for activities 3 and 4. Because of the difficulties, a rather wide distribution was obtained. Figure 49 shows the subobjectives for activities 3 and 4 were very important for EMH students.

For activities 5 and 6, 58 percent of the teachers reported using the strategies as prescribed; 33 percent reported some modification; and eight percent reported much modification. The carbon dioxide test solution (calcium hydroxide) worked perfectly, but students still had difficulties in measuring and recording time intervals. Most teachers used the breath-counting technique which was very successful. Some difficulties were encountered with the two worksheets in activity 5 because questions dealing both with carbon dioxide and oxygen were presented on the same worksheets. These worksheets have been separated to avoid this confusion.

For activity 6, stories of suffocation and drowning were very successful. One teacher wrote, "Activity 6 was a great success -- the discussions led into personal experience -- one boy had been a near victim of asphyxiation in the family camper. His story led to a lesson on safety. One boy asked, 'What is the difference between carbon monoxide and carbon dioxide?' We got out our dictionaries -- looked them up and learned the meanings of the prefixes 'mono' and 'di' -- Good experience."

Figure 50 shows student reactions to be very high across the three rating scales. Both activities were judged as very important for EMH students (see Figure 51).

Figure 52 shows the proportion of students who were able to perform the behaviors specified by the subobjectives for activities 5 and 6. In spite of the difficulties encountered measuring periods of time, 76 percent of the teachers reported that three-fourths or more of their students could perform the specified behaviors. Figure 53 shows the activities were very important for EMH students.

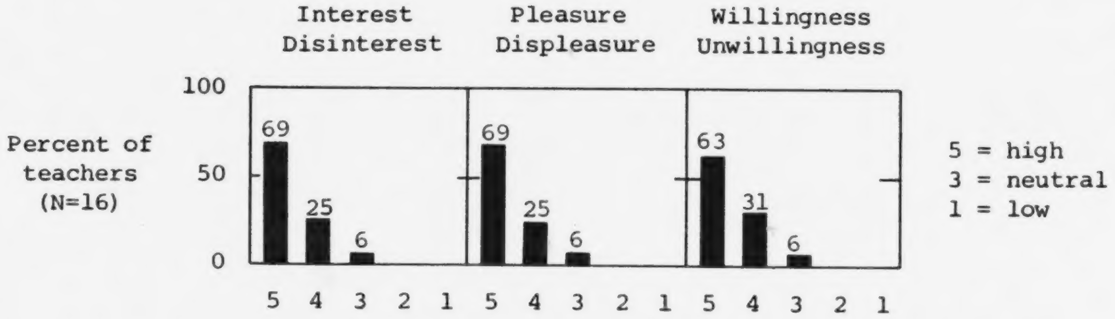


Figure 50. Reaction of the majority of students to activities 5 and 6

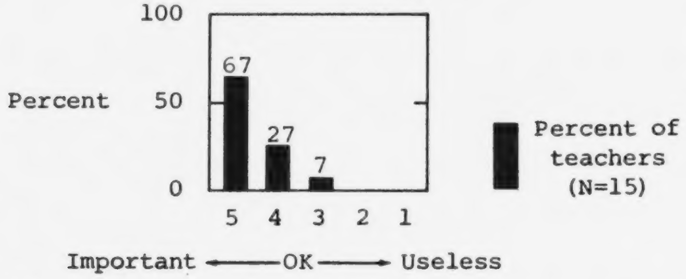


Figure 51. Importance to students of activities 5 and 6

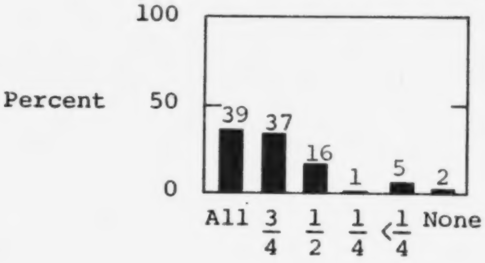


Figure 52. Proportion of students able to perform on subobjectives for activities 5 and 6

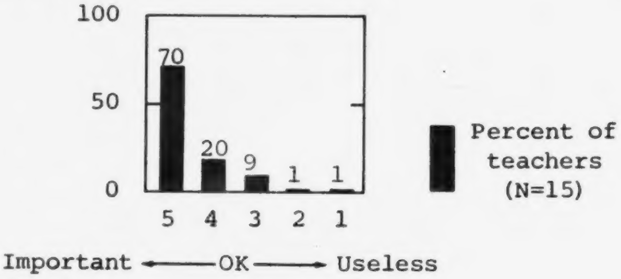
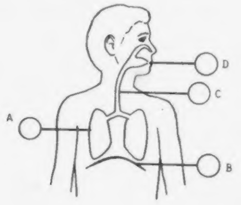


Figure 53. Importance of the subobjectives

Nine item pairs were designed to sample achievement on objective 200.

WHAT PART IS THE LUNG?

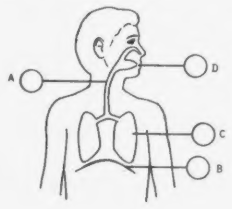
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



2A

WHAT PART IS THE LUNG?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



26B

Item pair 2-A, 26-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was 23 percent (from 68 to 91 percent). This gain can be accounted for by losses from all other response choices. There was a mean net loss of two percent (from 67 to 65 percent) for the control group. With these results we can clearly attribute experimental group gains to the effect of instruction. Biserial correlations are exceptionally high for this item pair.

Table 86. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	2-A	79	73	11	8	6	1	0	95	86	1	13	0	0	0	.64	.65
	26-B	95	19	8	64	7	1	0	79	0	0	97	3	0	0	.67	.60
Control	2-A	80	70	5	19	4	3	0	89	65	10	17	7	0	0	.45	.38
	26-B	89	24	4	65	7	0	0	80	21	6	65	6	1	0	.32	.65

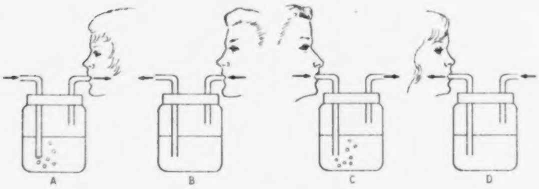
Table 87. Pretest to Posttest Changes
(The response choice for 2-A is cited first.)

Item Pair 2-A, 26-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	B	B+B	C	A	C+A	D	D	D+D
Experi-mental	+13	+33	+23	-10	-8	-8	+5	-19	-7	-6	-4	-6
Control	-5	0	-2	+5	+2	+4	-2	-3	-3	+3	-1	+1

Item pair 8-A, 3-B functions at the cognitive level of analysis. Mean total gain from pretest to posttest for the experimental group was 16 percent (from 37 to 53 percent). The gain can be accounted for

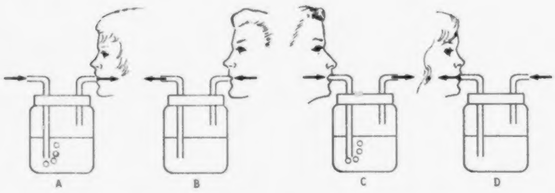
WHICH PERSON IS TESTING THE AMOUNT OF OXYGEN IN EXHALED AIR? 8A

MARK AN X ON THAT PERSON.



WHICH PERSON IS TESTING THE AMOUNT OF CARBON DIOXIDE IN EXHALED AIR? 3B

MARK AN X ON THAT PERSON.



by losses from all other response choices. A posttest level of achievement of 53 percent is entirely satisfactory due to the complex nature of the task involved in answering this question. There was a mean net loss of one percent (from 46 to 45 percent) from pretest to posttest for the control group. The gains registered by the experimental group can be attributed to the effect of instruction. Biserial correlations indicate that both items are good discriminators.

Table 88. Item Responses and Biserial Correlations for Experimental and Control Groups

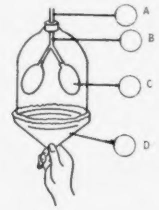
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	8-A 3-B	79 95	15 14	23 19	46 29	16 33	0 1	0 4	95 79	18 16	19 18	53 52	11 14	0 0	0 0	.48 .21	.31 .42
Control	8-A 3-B	80 89	11 16	16 24	48 44	21 16	4 1	0 0	89 80	16 24	20 10	45 45	17 20	0 0	2 1	.25 .29	.44 .49

Table 89. Pretest to Posttest Changes (The response choice for 8-A is cited first.)

Item Pair 8-A, 3-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experimental	+7	+23	+16	+3	+2	+3	-4	-1	-2	-5	-19	-13
Control	-3	+1	-1	+5	+8	+6	+4	-14	-5	-4	+4	0

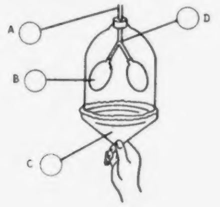
WHAT PART ON THE MODEL WORKS LIKE THE DIAPHRAGM (BREATHING-MUSCLE)? 9A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



WHAT PART ON THE MODEL WORKS LIKE LUNGS IN YOUR BODY? 7B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



Item pair 9-A, 7-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 21 percent (from 46 to 67 percent). This gain can be attributed to losses in all other response choices. There was a mean net gain of seven percent (from 41 to 48 percent) from pretest to posttest for the control group. The greater mean net gain from pretest to

Table 90. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	9-A	79	3	6	75	16	0	0	95	3	3	37	57	0	0	.19	.70
	7-B	95	4	71	4	21	0	0	79	1	78	14	6	0	0	.29	.36
Control	9-A	80	6	8	73	13	1	0	89	2	8	65	21	1	2	.30	.67
	7-B	89	3	67	7	20	2	0	80	1	78	4	18	0	0	.41	.66

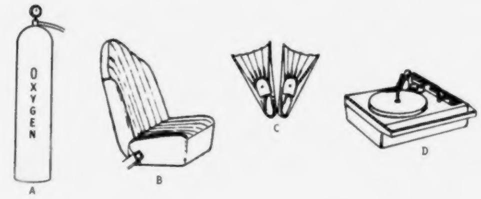
Table 91. Pretest to Posttest Changes (The response choice for 9-A is cited first.)

Item Pair 9-A, 7-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	A	A+A	B	D	B+D	C	C	C+C
Experimental	+41	+7	+21	0	-3	-2	-3	-15	-10	-38	+10	-10
Control	+8	+11	+7	-4	-2	-2	0	-2	-1	-8	-3	-5

posttest and the higher posttest achievement level of the experimental group enable us to attribute the success of the experimental group to the effect of instruction. The biserial correlations indicate that both items are good discriminators.

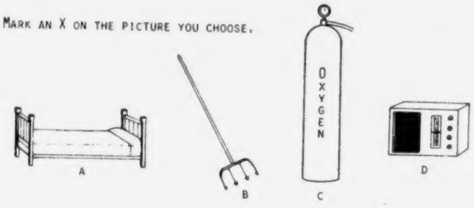
IF YOU WERE GOING ON A TRIP IN A SUBMARINE, WHICH OF THESE WOULD YOU NEED MOST? 11A

MARK AN X IN THE PICTURE YOU CHOOSE.



IF YOU WERE GOING ON A TRIP IN A SUBMARINE, WHICH OF THESE WOULD YOU NEED MOST? 1B

MARK AN X ON THE PICTURE YOU CHOOSE.



Item pair 11-A, 1-B is a baseline item and functions at the cognitive level of analysis. Mean net gain from pretest to posttest for the experimental group was 12 percent (from 81 to 93 percent). The high pretest level indicates that this item is measuring data already known by many of the students in the experimental group. The pretest-to-posttest gain can be attributed to losses in all other response choices. For the control group, there was a mean net loss of one percent (from 89 to 88 percent). The high achievement level of the control group on the pretest confirms the conclusion that most EMH students in our sample are familiar with the material covered by this item pair. The pretest-to-posttest gains in the experimental group can be attributed to the effect of instruction. The biserial correlations indicate that both items are good discriminators.

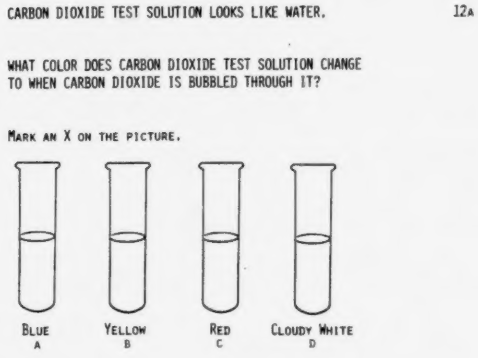
Table 92. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	11-A	79	85	6	9	0	0	0	95	92	7	0	1	0	0	.42	.46
	1-B	95	14	1	77	8	0	0	79	3	0	94	4	0	0	.35	.61
Control	11-A	80	90	4	5	1	0	0	89	85	3	7	2	1	1	.73	.55
	1-B	89	8	1	89	1	1	0	80	4	0	91	5	0	0	.41	.58

Table 93. Pretest to Posttest Changes (The response choice for 11-A is cited first.)

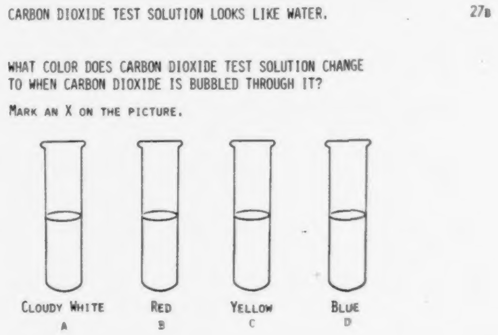
Item Pair 11-A, 1-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	A	B+A	C	B	C+B	D	D	D+D
Experi-mental	+7	+17	+12	+1	-11	-5	-9	-1	-5	+1	-4	-2
Control	-5	+2	-1	-1	-4	-3	+2	-1	+1	+1	+4	+2

Item pair 12-A, 27-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was nine percent (from 59 to 68 percent). The pretest-to-posttest gain can be attributed to losses in all response choices except blue (A in Form A, D in Form B), where a mean net gain of nine percent (from nine to 18 percent) was recorded. This result confirms reports by the


CARBON DIOXIDE TEST SOLUTION LOOKS LIKE WATER. 12A

WHAT COLOR DOES CARBON DIOXIDE TEST SOLUTION CHANGE TO WHEN CARBON DIOXIDE IS BUBBLED THROUGH IT?

Mark an X on the picture.
Blue
A
Yellow
B
Red
C
Cloudy White
D


CARBON DIOXIDE TEST SOLUTION LOOKS LIKE WATER. 27B

WHAT COLOR DOES CARBON DIOXIDE TEST SOLUTION CHANGE TO WHEN CARBON DIOXIDE IS BUBBLED THROUGH IT?

Mark an X on the picture.
Cloudy White
A
Red
B
Yellow
C
Blue
D

Table 94. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	12-A	79	1	15	14	70	0	0	95	12	4	4	80	0	0	.35	.62
	27-B	95	47	17	19	16	0	1	79	53	4	18	25	0	0	.46	.28
Control	12-A	80	5	5	10	80	0	0	89	4	6	9	80	0	1	.30	.61
	27-B	89	69	10	7	15	0	0	80	76	8	10	6	0	0	.60	.60

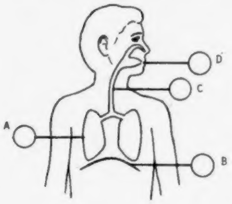
Table 95. Pretest to Posttest Changes (The response choice for 12-A is cited first.)

Item Pair 12-A, 27-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	C	B+C	C	B	C+B
Experimental	+10	+6	+9	+11	+9	+9	-11	-1	-3	-10	-13	-12
Control	0	+7	+4	-1	-9	-5	+1	+3	+2	-1	-2	-1

teachers of confusion because both the carbon dioxide and oxygen tests were presented on the same worksheet. Doing the activities on separate days and on separate worksheets should eliminate this confusion. There was a mean net gain from pretest to posttest of four percent (from 74 to 78 percent) for the control group. The pretest-to-posttest gain in the control group can be attributed to instruction, but from pretest scores it is evident that more students in the control group had prior knowledge of testing for carbon dioxide than did the students in the experimental group. The change in biserial correlations from pretest to posttest confirms the confusion of the experimental group and led us to hypothesize that some instruction may have occurred in the control group. Colored slides were used for this pair to reinforce the word labels of colors and compensate for students who could not match the word with the corresponding color.

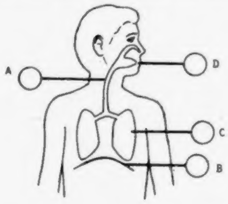
WHAT PART IS THE WINDPIPE? 13A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



WHAT PART IS THE WINDPIPE? 15B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



Item pair 13-A, 15-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 36 percent (from 52 to 88 percent). This gain can be attributed to losses in all other response choices. Mean net gain from pretest to posttest for the control group was 17 percent (from 49 to

Table 96. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	13-A	79	6	22	48	24	0	0	95	1	4	87	7	0	0	.41	.52
	15-B	95	56	8	13	23	0	0	79	90	0	3	8	0	0	.54	.46
Control	13-A	80	32	5	44	19	0	0	89	12	7	65	13	0	2	.39	.41
	15-B	89	54	11	15	19	1	0	80	68	6	10	16	0	0	.63	.68

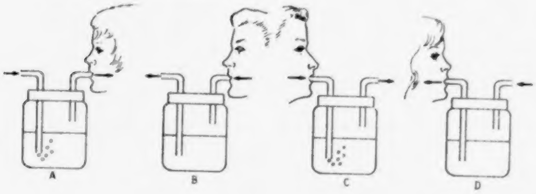
Table 97. Pretest to Posttest Changes (The response choice for 13-A is cited first.)

Item Pair 13-A, 15-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	C	A+C	B	B	B+B	D	D	D+D
Experimental	+39	+34	+36	-5	-10	-8	-18	-8	-13	-17	-15	-16
Control	+21	+14	+17	-20	-5	-12	+2	-5	-1	-6	-3	-5

66 percent). The greater pretest-to-posttest gains in the experimental group can be attributed to the effect of instruction. The biserial correlations indicate that both items are good discriminators.

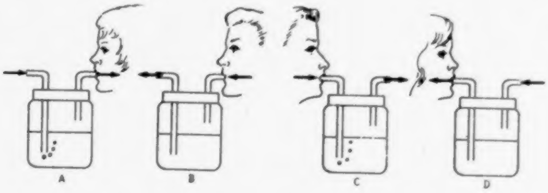
WHICH PERSON IS TESTING THE AMOUNT OF CARBON DIOXIDE IN INHALED AIR? 16A

MARK AN X ON THAT PERSON.



WHICH PERSON IS TESTING THE AMOUNT OF OXYGEN IN INHALED AIR? 19B

MARK AN X ON THAT PERSON.



Item pair 16-A, 19-B functions at the cognitive level of analysis. Mean net gain from pretest to posttest for the experimental group was 15 percent (from 34 to 49 percent). The gain can be attributed to losses in all other distractors. For the control group the pretest and posttest levels of achievement were both 28 percent. We can attribute the gains for the experimental group to the effect of instruction. In view of the complexity of the task required in answering this item, a 49 percent level of achievement is very satisfactory. The biserial correlations indicate that both items are good discriminators.

Table 98. Item Responses and Biserial Correlations for Experimental and Control Groups

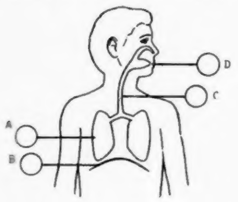
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	16-A	79	33	14	28	25	0	0	95	42	15	21	22	0	0	.08	.33
	19-B	95	35	18	19	27	1	0	79	56	5	13	27	0	0	.31	.35
Control	16-A	80	26	20	30	24	0	0	89	25	13	26	31	2	2	.43	.44
	19-B	89	29	25	27	18	1	0	80	31	8	34	28	0	0	.30	.30

Table 99. Pretest to Posttest Changes
(The response choice for 16-A is cited first.)

Item Pair 16-A, 19-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experimental	+9	+21	+15	+1	-13	-6	-7	-6	-6	-3	0	-2
Control	-1	+2	0	-7	-17	-12	-4	+7	+2	+7	+10	+9

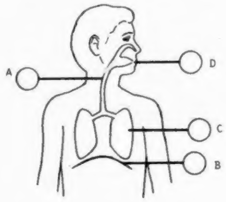
WHAT PART IS THE DIAPHRAGM (BREATHING-MUSCLE)? 22A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



WHAT PART IS THE DIAPHRAGM (BREATHING-MUSCLE)? 18B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



Item pair 22-A, 18-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 22 percent (from 28 to 50 percent) and can be attributed to losses on all other response choices. Mean net gain from pretest to posttest for the control group was two percent (from 30 to 32 percent). The pretest-to-posttest gain for the experimental group can clearly be attributed to the effect of instruction. The biserial correlations

Table 100. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	22-A	79	43	24	13	19	1	0	95	32	51	6	12	0	0	.12	.49
	18-B	95	7	31	49	12	1	0	79	3	48	42	6	1	0	.15	.12
Control	22-A	80	39	31	11	18	1	0	89	38	35	9	16	0	2	.52	.41
	18-B	89	20	29	36	13	1	0	80	13	29	38	19	1	1	.37	.59

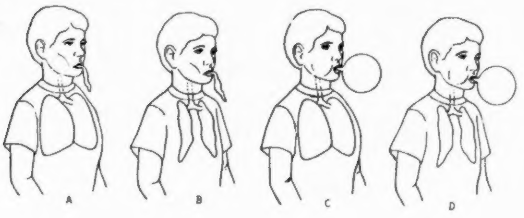
Table 101. Pretest to Posttest Changes
(The response choice for 22-A is cited first.)

Item Pair 22-A, 18-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	C	A+C	C	A	C+A	D	D	D+D
Experimental	+27	+17	+22	-11	-7	-9	-7	-4	-5	-7	-6	-6
Control	+4	0	+2	-1	+2	+1	-2	-7	-5	-2	+6	+2

indicate that both items are good discriminators. The low biserial correlation on the Form B posttest is attributed to a student effect and not due to item construction, since both items are essentially identical.

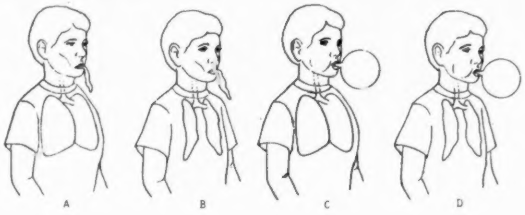
WHAT HAPPENS WHEN YOU EXHALE? 30A

MARK AN X ON THE PICTURE.



WHAT HAPPENS WHEN YOU INHALE? 24B

MARK AN X ON THE PICTURE.



Item pair 30-A, 24-B functions at the congitive level of analysis. Mean total gain from pretest to posttest for the experimental group was three percent (from 24 to 27 percent). Control group pretest and posttest achievement levels remained stable at 29 percent. Although small gains were recorded in the experimental group, future testing should result in much higher gains if the revised materials are used. The use of supporting films and the functioning torso should reinforce this subject matter. Biserial correlations are exceptionally high, indicating that both items are discriminating well between high and low achievers in both the experimental and control groups.

Table 102. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	30-A	79	23	33	33	9	3	0	95	20	35	25	20	0	0	.36	.83
	24-B	95	39	42	14	4	1	0	79	34	38	23	5	0	0	.38	.47
Control	30-A	80	13	31	30	25	1	0	89	25	37	16	21	0	1	.22	.50
	24-B	89	33	28	33	4	2	0	80	38	41	13	9	0	0	.43	.38

Table 103. Pretest to Posttest Changes (The response choice for 30-A is cited first.)

Item Pair 30-A, 24-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	B	B+B	C	C	C+C
Experi-mental	+11	-5	+3	-3	+1	0	+2	-4	-2	-8	+9	+1
Control	+4	+5	0	+12	+5	+9	+6	+13	+10	-14	-20	-17

Objective 201. Students will identify respiration as a necessity for body action. Five student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 7 and 8, 75 percent of the teachers used the strategies as described; 19 percent reported some modification; and one teacher replaced the strategies by having students run in place instead of doing the pushups as described in the activity. No serious problems were encountered in activities 7 and 8. Several teachers reported, "Very successful activity. We posted a chart recording their improvements in exercises and the carry-over in attitudes to other subject areas was good."

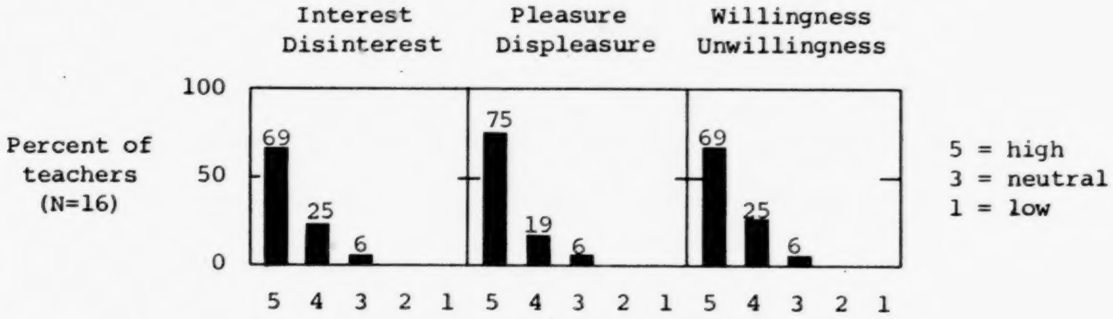


Figure 54. Reaction of the majority of students to activities 7 and 8

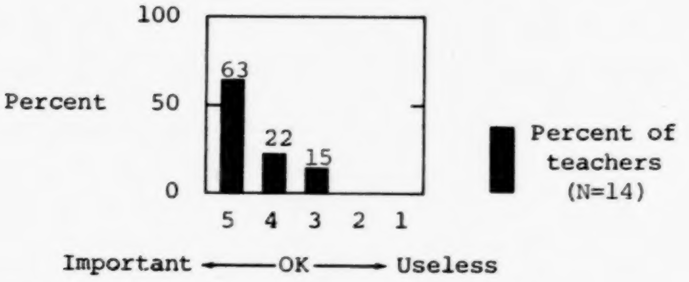


Figure 55. Importance to students of activities 7 and 8

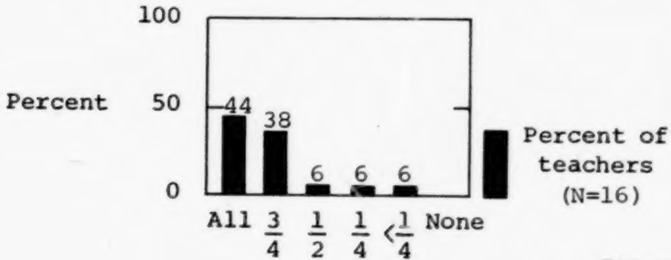


Figure 56. Proportion of students able to perform on subobjectives for activities 7 and 8

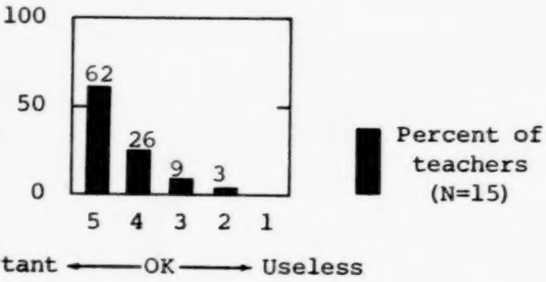


Figure 57. Importance of the subobjectives

Figure 54 shows student reactions to be very high across the three rating scales. Both activities were important for EMH students (see Figure 55). Figure 56 shows the proportion of students who were able to perform the behaviors specified by the subobjectives for activities

7 and 8. Eighty-two percent of the teachers reported that three-fourths or more of their students were successful. Figure 57 shows that teachers rated the subobjectives as being very important for EMH students.

For activities 9 and 10, 56 percent of the teachers used the strategies as described and 44 percent reported some modification. The major problem encountered in this series of activities was that some teachers used fresh bread soaked in vegetable oil as an energy source and it would not burn. These instructions have been changed to direct the teachers to use dry bread soaked in vegetable oil and leave it overnight before attempting to burn it. This technique was used successfully by several teachers and has been verified by the BSCS staff.

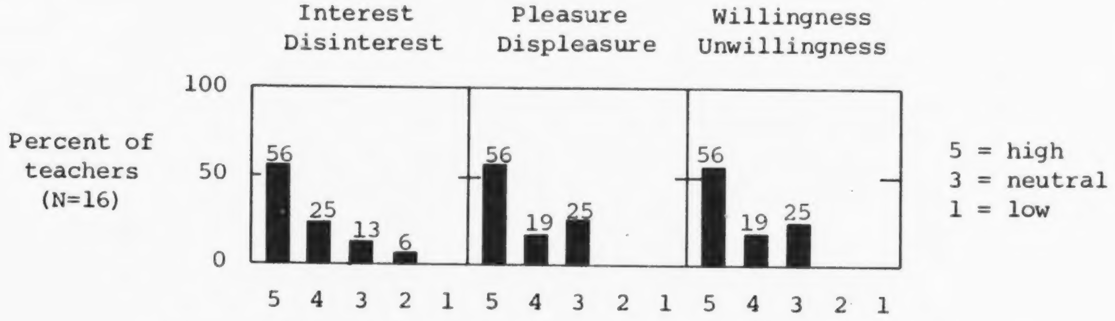


Figure 58. Reaction of the majority of students to activities 9 and 10

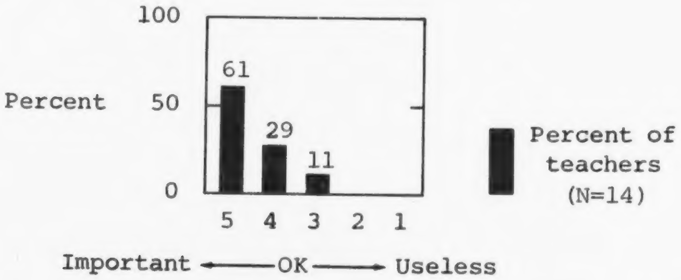


Figure 59. Importance to students of activities 9 and 10

Figure 58 shows student reactions to be high across the three scales. The problems encountered trying to burn fresh bread could account for the slightly lower rating than the previous activities received. Both activities were judged important for EMH students (see Figure 59).

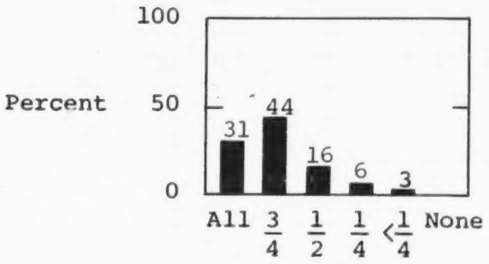


Figure 60. Proportion of students able to perform on subobjectives for activities 9 and 10

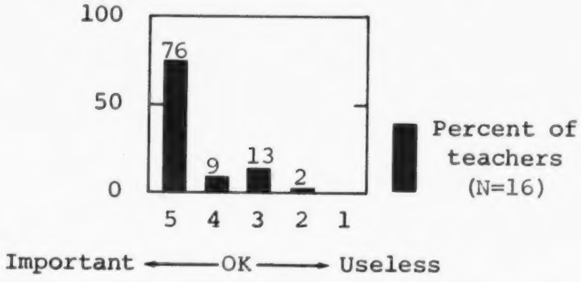


Figure 61. Importance of the subobjectives

Figure 60 shows the proportion of students who were able to perform the behaviors specified by the subobjectives for activities 9 and 10. The lower success rate is attributed to the problems encountered in burning bread in activity 9, which was a basis for several conclusions which should have been drawn by the students. Student performance on each individual subobjective supports this conclusion, since student success was high on all other subobjectives. Figure 61 shows that teachers rated the subobjectives as being very important for EMH students. Teachers who marked the "2" were some of the ones who encountered difficulties with the activity.

For activity 11, 75 percent of the teachers used the strategies as described; 19 percent reported some modifications; and six percent reported much modification. This sequence of slides was designed to help bring the circulatory, respiratory and digestive systems together, but two problems were encountered. First, as was the case with the oxygen and carbon dioxide test worksheets, it appears that too much has been presented at once on the activity 11 worksheet. The sequence was revised to present the slides in two activities instead of one. The second problem was a matter of modifying artwork on the slides. Lungs and diaphragm were added and the digestive system was darkened to help students distinguish between intestines, windpipe and blood vessels.

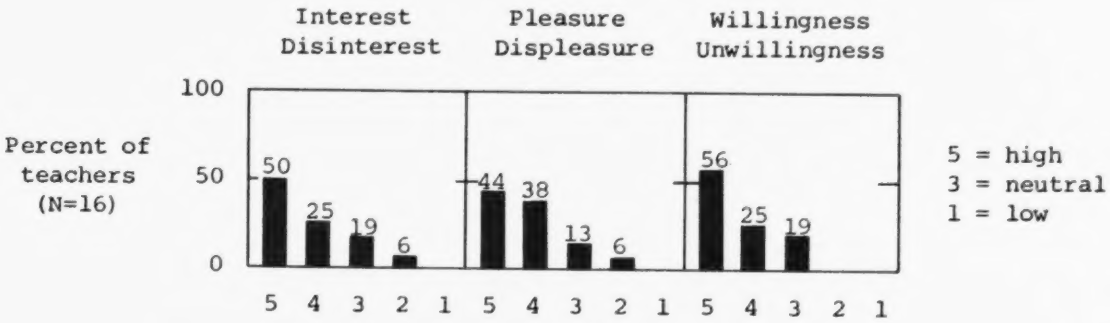


Figure 62. Reaction of the majority of students to activity 11

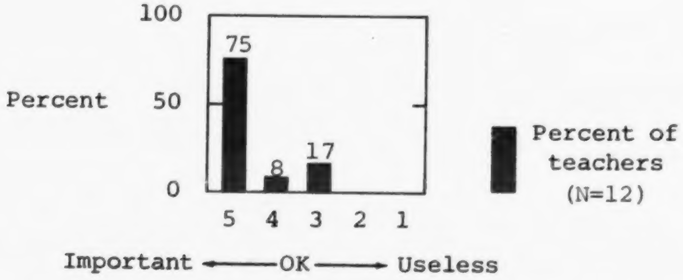


Figure 63. Importance to students of activity 11

Figure 62 shows student reactions to be high across the three rating scales, but the problems encountered lowered the ratings somewhat from the previous activities. The activity was judged to be important for EMH students (see Figure 63).

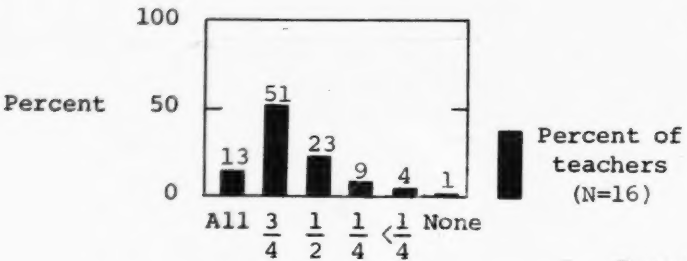


Figure 64. Proportion of students able to perform on subobjectives for activity 11

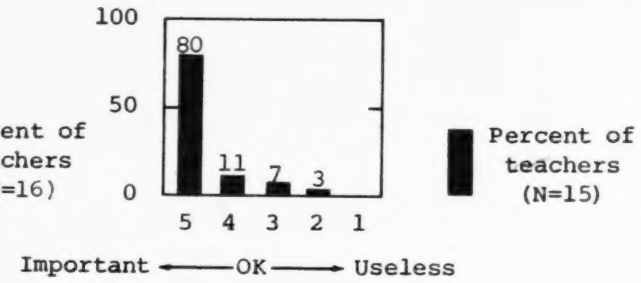
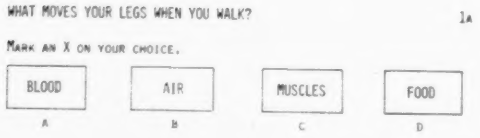


Figure 65. Importance of the subobjectives

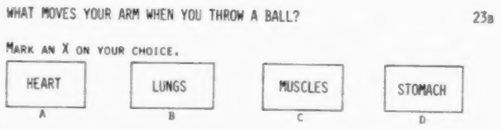
Figure 64 shows the proportion of students who were able to perform the behaviors specified by the subobjectives for activity 11. This figure is slightly skewed because one of the subobjectives deals with student knowledge before seeing the slides. In spite of this and minor problems with the slides themselves, 87 percent of the teachers reported that one-half or more of their students were able to perform the desired behaviors. Figure 65 shows that teachers ranked the subobjectives much higher than those of previous activities.

Ten item pairs were designed to sample achievement on objective 201.


WHAT MOVES YOUR LEGS WHEN YOU WALK? 1A

MARK AN X ON YOUR CHOICE.

BLOOD A
AIR B
MUSCLES C
FOOD D


WHAT MOVES YOUR ARM WHEN YOU THROW A BALL? 23B

MARK AN X ON YOUR CHOICE.

HEART A
LUNGS B
MUSCLES C
STOMACH D

Item pair 1-A, 23-B is a baseline item and functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 16 percent (from 71 to 87 percent). This gain can be attributed to losses in all other response choices. There was a mean net gain of six percent (from 75 to 81) in the control group.

Table 104. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	1-A	79	22	4	70	5	0	0	95	2	1	92	5	0	0	.38	.62
	23-B	95	12	8	72	7	1	0	79	5	8	82	4	1	0	.41	.57
Control	1-A	80	11	10	68	10	0	1	89	11	8	75	4	1	0	.44	.46
	23-B	89	6	6	81	7	1	0	80	4	5	88	4	0	0	.28	.63

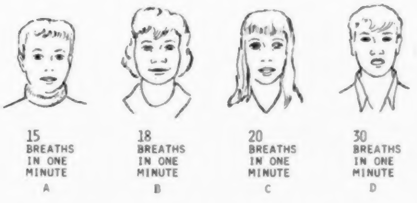
Table 105. Pretest to Posttest Changes
(The response choice for 1-A is cited first.)

Item Pair 1-A, 23-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experimental	+22	+10	+16	-20	-7	-14	-3	0	-2	0	-3	-1
Control	+7	+7	+6	0	-2	0	-2	-1	-1	-6	-3	-4

The greater gains and higher posttest achievement level of the experimental group enable us to attribute the success of the experimental group to the effect of instruction. The biserial correlations indicate that the items are good discriminators.

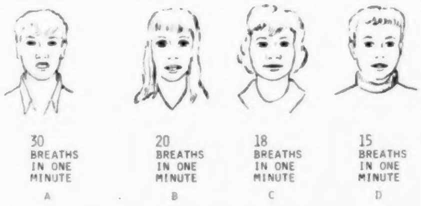
WHICH PERSON HAS RUN THE MOST? 5A

MARK AN X ON THAT PERSON.


15 BREATHS IN ONE MINUTE
A
18 BREATHS IN ONE MINUTE
B
20 BREATHS IN ONE MINUTE
C
30 BREATHS IN ONE MINUTE
D

WHICH OF THE FOLLOWING HAS JUST FINISHED STRENUOUS EXERCISE? 12B

MARK AN X ON THAT PERSON.


30 BREATHS IN ONE MINUTE
A
20 BREATHS IN ONE MINUTE
B
18 BREATHS IN ONE MINUTE
C
15 BREATHS IN ONE MINUTE
D

Item pair 5-A, 12-B is a baseline item and functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was nine percent (from 72 to 81 percent). This gain can be attributed to a shift from all other response choices. The control group registered a mean net loss of three percent from

Table 106. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	5-A	79	9	1	11	78	0	0	95	6	4	5	84	0	0	.41	.39
	12-B	95	66	7	6	19	1	0	79	78	10	5	6	0	0	.45	.65
Control	5-A	80	0	0	4	96	0	0	89	2	2	4	89	1	1	.43	.73
	12-B	89	69	11	9	10	1	0	80	69	4	5	23	0	0	.48	.18

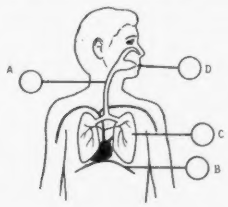
Table 107. Pretest to Posttest Changes (The response choice for 5-A is cited first.)

Item Pair 5-A, 12-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	C	B+C	C	B	C+B
Experi-mental	+6	+12	+9	-3	-13	-8	+3	-1	0	-6	+3	-2
Control	-7	0	-3	+2	+13	+8	+2	-4	-2	0	-7	-4

pretest to posttest, allowing us to attribute the experimental group gains to the effect of instruction. The pretest level of achievement indicates that most EMH students in our sample had prior knowledge of the relationship of breathing rate and exercise. This does not mean, however, that they understand the reason for the relationship. Biserial correlations indicate that both items are good discriminators.

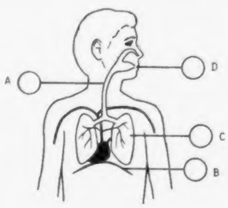
IN WHAT PART DOES OXYGEN FROM THE AIR GO INTO THE BLOOD? 15A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



IN WHAT PART DOES CARBON DIOXIDE GO OUT OF THE BLOOD? 5B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



Item pair 15-A, 5-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 12 percent (from 53 to 65 percent). The gain can be attrib-

Table 108. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	15-A	79	4	19	67	9	0	1	95	5	14	67	14	0	0	.50	.37
	5-B	95	3	36	38	22	1	0	79	5	15	62	18	0	0	.42	.62
Control	15-A	80	10	10	71	6	3	0	89	13	19	51	13	1	2	.23	.07
	5-B	89	8	34	45	13	0	0	80	13	35	43	10	0	0	.28	.41

Table 109. Pretest to Posttest Changes
(The response choice for 15-A is cited first.)

Item Pair 15-A, 5-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experi-mental	0	+24	+12	+1	+2	+2	-5	-21	-13	+5	-4	0
Control	-20	-2	-11	+3	+5	+4	+9	+1	+5	+7	-3	+2

uted to losses in all response choices except A in both forms, the windpipe, where pretest-to-posttest gain of two percent (from three to five percent) was recorded. Although total percent is small, this minor problem should be eliminated by the functioning torso in the revised materials. There was a mean net loss of 11 percent (from 58 to 47 percent) from pretest to posttest in the control group. The pretest-to-posttest gain in the experimental group can be attributed to the effect of instruction. The biserial correlations show that both items are good discriminators.

WHAT COMBINES WITH FOOD IN THE MUSCLE TO RELEASE ENERGY: CARBON DIOXIDE, OXYGEN, WATER, DIGESTIVE JUICE. 17A

MARK AN X ON YOUR CHOICE.

CARBON DIOXIDE	OXYGEN	WATER	DIGESTIVE JUICE
A	B	C	D

WHAT COMBINES WITH OXYGEN IN THE MUSCLE TO RELEASE ENERGY: CARBON DIOXIDE, WATER, DIGESTIVE JUICE, FOOD. 17B

MARK AN X ON YOUR CHOICE.

CARBON DIOXIDE	WATER	DIGESTIVE JUICE	FOOD
A	B	C	D

Item pair 17-A, 17-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was ten percent (from 31 to 41 percent). The gain can be accounted

Table 110. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	17-A	79	10	29	20	39	1	0	95	19	35	21	25	0	0	.27	.33
	17-B	95	28	15	25	32	0	0	79	25	11	14	48	1	0	.30	.54
Control	17-A	80	13	21	16	48	3	0	89	16	19	19	43	2	1	.30	.02
	17-B	89	28	16	30	25	1	0	80	23	11	34	33	0	0	.06	.10

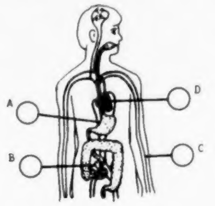
Table 111. Pretest to Posttest Changes
(The response choice for 17-A is cited first.)

Item Pair 17-A, 17-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	D	B+D	A	A	A+A	C	B	C+B	D	C	D+C
Experi-mental	+6	+16	+10	+9	-3	+3	+1	-4	-1	-14	-11	-12
Control	-2	+8	+3	+3	-5	-2	+3	-5	-1	-5	+4	0

for by losses from all other response choices except carbon dioxide, where a slight gain was noticed. The gain from pretest to posttest for carbon dioxide on Form A of nine percent came mainly from one class where the teacher was confused and modified the teaching strategies. The relatively low level of posttest achievement confirms the feedback from teachers that the worksheet in activity 11 should become two worksheets dealing with two separate activities. The mean total gain from pretest to posttest for the control group was three percent, allowing us to attribute the experimental group gains to the effect of instruction. Biserial correlations were much higher for the experimental group than for the control group, confirming the effect of instruction.

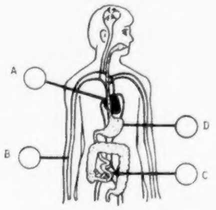
WHERE DOES BLOOD PICK UP FOOD? 18A

MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT TOUCHES THE PART.



WHERE DOES FOOD ENTER THE BLOOD? 13B

MARK AN X IN THE CIRCLE AT THE END OF THE LINE THAT TOUCHES THE PART.



Item pair 18-A, 13-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was three percent (from 41 to 44 percent). This gain is accounted for by a loss from choosing the heart. These results confirmed the need to strengthen activity 11 to bring the relationship between the digestive and circulatory systems into a sharper focus. Mean total gain from pretest to posttest for the control group was four percent (from 21 to 25 percent). Although the posttest level of achievement of the experimental group was higher than that of the control group, the pretest level was also higher. A note was added to the _Teacher's Test Administration Guide and Answer Key_ that this pair of items can help the teacher identify those students who are having difficulties identifying and separating the roles of the heart, stomach and intestines. Although the pretest-to-posttest gains of the experimental

Table 112. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	18-A	79	22	38	10	30	0	0	95	25	39	10	25	0	0	.42	.58
	13-B	95	32	5	44	19	0	0	79	23	13	49	15	0	0	.39	.53
Control	18-A	80	41	19	4	34	3	0	89	33	27	3	35	0	2	.17	.03
	13-B	89	30	7	22	39	1	0	80	35	4	23	39	0	0	.01	.14

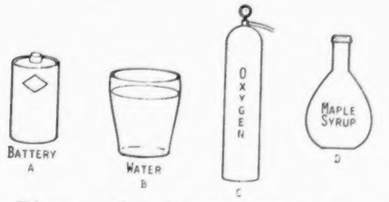
Table 113. Pretest to Posttest Changes
(The response choice for 18-A is cited first.)

Item Pair 18-A, 13-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experimental	+1	+5	+3	+3	-4	0	0	+8	+4	-5	-9	-7
Control	+8	+1	+4	-8	0	-4	-1	-3	-3	+1	+5	+3

and control groups are very similar, the biserial correlations clearly indicate an instructional effect in the experimental group.

WHICH DOES YOUR BODY USE FOR ENERGY?

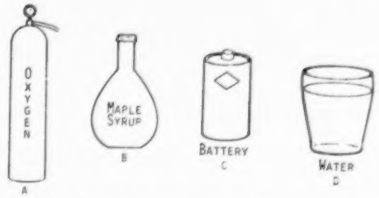
MARK AN X ON YOUR CHOICE.



19A WHICH DOES YOUR BODY USE FOR ENERGY?

4B

MARK AN X ON YOUR CHOICE.



Item pair 19-A, 4-B functions at the cognitive level of knowledge. There was a mean total loss from pretest to posttest for the experimental group of four percent (from 11 to seven percent). The control group registered a mean total gain of 11 percent (from eight to 19 percent). Several problems were identified here. First, student interviews verified that syrup was thought of as a condiment and not an energy source, which led to using cookies in both Forms A and B as the correct response choice. A drastic shift occurred in the experimental group from choosing water as an energy source on the pretest to choosing oxygen as the energy source on the posttest. The materials were revised to clarify the roles of food and oxygen in producing energy. The gain in scores and increase in biserial correlations for the control group indicate that instruction on this topic probably did occur in several of the control group classes.

Table 114. Item Responses and Biserial Correlations
for Experimental and Control Groups

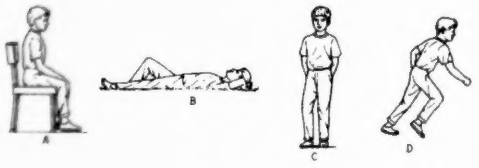
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	19-A	79	1	34	57	8	0	0	95	7	26	59	7	0	0	-.01	.04
	4-B	95	33	13	1	54	0	0	79	70	8	3	20	0	0	.16	-.04
Control	19-A	80	3	31	56	9	1	0	89	2	30	43	24	0	1	-.17	.71
	4-B	89	31	8	3	56	1	0	80	29	13	9	50	0	0	.05	.27

Table 115. Pretest to Posttest Changes
(The response choice for 19-A is cited first.)

Item Pair 19-A, 4-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	C	A+C	B	D	B+D	C	A	C+A
Experi-mental	-1	-5	-4	+6	+2	+4	-8	-34	-21	+2	+37	+19
Control	+15	+5	+11	-1	+6	+2	-1	-6	-4	-13	-2	-7

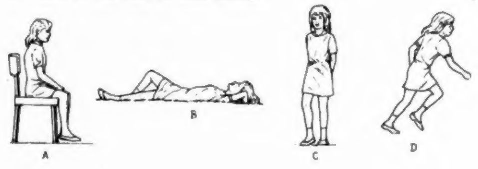
WHICH BOY IS USING THE MOST OXYGEN? 23A

MARK AN X ON THE BOY OF YOUR CHOICE.



WHICH GIRL IS EXHALING THE MOST CARBON DIOXIDE? 14B

MARK AN X ON THE GIRL OF YOUR CHOICE.



Item pair 23-A, 14-B is a baseline item and functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 18 percent (from 72 to 90 percent). The gain can be accounted for by losses from all other response choices. Mean total gain for the control group was five percent (from 70 to 75 percent). A comparison of the experimental-control group gains enabled us to attribute experimental group gains to the effect of instruction.

Table 116. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	23-A	79	1	14	3	81	1	0	95	1	6	1	92	0	0	.39	.19
	14-B	95	2	26	8	63	0	0	79	3	6	4	87	0	0	.35	.87
Control	23-A	80	0	16	3	81	0	0	89	0	15	2	81	1	1	.38	.48
	14-B	89	4	34	1	60	1	0	80	4	23	5	69	0	0	.30	.51

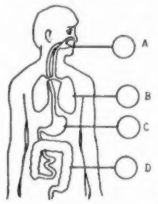
Table 117. Pretest to Posttest Changes
(The response choice for 23-A is cited first.)

Item Pair 23-A, 14-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	B	B+B	C	C	C+C
Experi-mental	+11	+24	+18	0	+1	0	-8	-20	-14	-2	-4	-4
Control	0	+9	+5	0	0	0	-1	-11	-6	-1	+4	+1

The relationship between body exercise and exhaling carbon dioxide is clearly established. Biserial correlations indicate that both items are good discriminators.

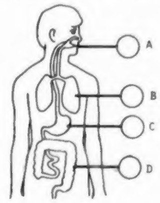
IN WHAT PART DOES OXYGEN FROM THE AIR GO INTO THE BLOOD? 24A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



IN WHAT PART DOES CARBON DIOXIDE GO OUT OF THE BLOOD? 22B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE PART.



Item pair 24-A, 22-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 18 percent (from 28 to 46 percent). This gain can be accounted for by losses from all other response choices, except the mouth. Mean total gain for the control group was seven percent (from

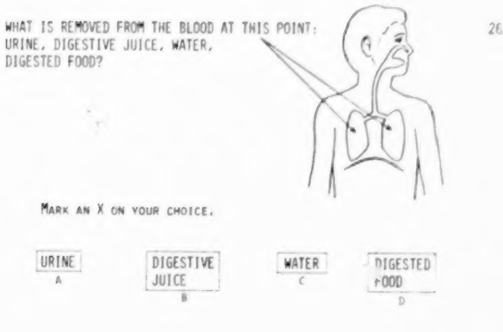
23 to 30 percent). The experimental group gain is attributed to the effect of instruction. Biserial correlations indicate that both items are good discriminators.

Table 118. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	24-A	79	20	35	22	22	1	0	95	26	49	15	9	0	0	.55	.40
	22-B	95	16	21	12	52	0	0	79	16	42	13	29	0	0	.20	.28
Control	24-A	80	15	29	33	23	1	0	89	11	33	36	18	1	1	.43	.39
	22-B	89	13	18	24	42	3	0	80	18	26	23	34	0	0	.15	.28

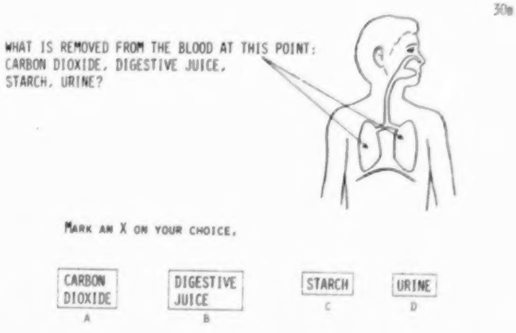
Table 119. Pretest to Posttest Changes (The response choice for 24-A is cited first.)

Item Pair 24-A, 22-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	C	C+C	D	D	D+D
Experi-mental	+14	+21	+18	+6	0	+3	-7	+1	-3	-13	-23	-18
Control	+4	+8	+7	-4	+5	0	+3	-1	+2	-5	-8	-7


26A

WHAT IS REMOVED FROM THE BLOOD AT THIS POINT: URINE, DIGESTIVE JUICE, WATER, DIGESTED FOOD?

MARK AN X ON YOUR CHOICE.


30B

WHAT IS REMOVED FROM THE BLOOD AT THIS POINT: CARBON DIOXIDE, DIGESTIVE JUICE, STARCH, URINE?

MARK AN X ON YOUR CHOICE.

Item pair 26-A, 30-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 14 percent (from 21 to 35 percent). There was a mean net loss of four percent (from 19 to 15 percent) for the control group. We can already attribute experimental group gains to the effect of instruction. We believe that the posttest success level will be much higher with the use of supporting films and the functioning torso with the revised materials. Biserial correlations are very good for the experimental group.

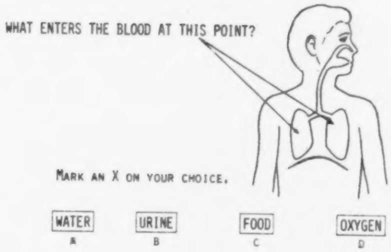
Table 120. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
		N	Percent of N						N	Percent of N							
			A	B	C	D	M	O		A	B	C	D	M	O	Pre	Post
Experimental	26-A	79	18	25	20	34	3	0	95	21	22	24	33	0	0	.34	.41
	30-B	95	22	33	26	16	3	0	79	47	20	16	14	3	0	.89	.74
Control	26-A	80	21	19	13	45	3	0	89	19	21	9	47	2	1	-.16	-.10
	30-B	89	25	36	22	12	4	0	80	21	23	29	28	0	0	.18	.30

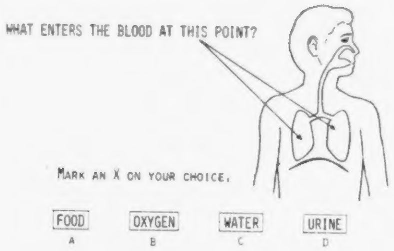
Table 121. Pretest to Posttest Changes (The response choice for 26-A is cited first.)

Item Pair 26-A, 30-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	D	A+D	B	B	B+B	D	C	D+C
Experimental	+4	+25	+14	+3	-2	+1	-3	-13	-8	-1	-10	-6
Control	-4	-4	-4	-2	+16	+7	+2	-13	-6	+2	+7	+5

Item pair 28-A, 28-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 16 percent (from 43 to 59 percent). This can be accounted for by losses from all other response choices. Mean total gain for the control group was six percent (from 46 to 52 percent). The experimental group gains are attributed to the effect of instruction.


WHAT ENTERS THE BLOOD AT THIS POINT?
MARK AN X ON YOUR CHOICE.
WATER
A
URINE
B
FOOD
C
OXYGEN
D

28A


WHAT ENTERS THE BLOOD AT THIS POINT?
MARK AN X ON YOUR CHOICE.
FOOD
A
OXYGEN
B
WATER
C
URINE
D

28B

Although students readily associate carbon dioxide with exhaled air and recognize its relationship to exercise, it appears that approximately one-third do not yet know that carbon dioxide enters the lungs from the blood. The more detailed reviews should improve this situation.

Table 122. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi- mental	28-A	79	11	6	25	52	5	0	95	8	13	21	57	1	0	.39	.61
	28-B	95	32	34	13	17	5	0	79	18	62	13	4	4	0	.54	.70
Control	28-A	80	13	6	25	53	4	0	89	9	6	28	54	2	1	.48	.45
	28-B	89	13	40	31	11	3	0	80	19	49	18	14	1	0	.59	.59

Table 123. Pretest to Posttest Changes
(The response choice for 28-A is cited first.)

Item Pair 28-A, 28-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	C	A+C	B	D	B+D	C	A	C+A
Experi- mental	+5	+28	+16	-3	0	-2	+7	-13	-3	-4	-14	-9
Control	+1	+9	+6	-4	-13	-9	0	+3	+1	+3	+6	+4

Objective 202. Students will infer a relationship between waste and internal body processes. Five student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 12 and 13, 81 percent of the teachers used the strategies as described; 19 percent reported some modifications. Ninety-three percent of the teachers reported that the strategies were successful. A minor problem occurred when teachers attempted to burn bread with cooking oil, but this was simply a repeat of an earlier problem that most teachers had already overcome. Many positive comments were received concerning these two activities, such as, "When discussing elimination we invariably get on the subject of personal hygiene. My student teacher overheard two of the boys seriously and privately discussing what they should do about 'teaching' #3101 how to clean himself in the bathroom -- a day or two later one of the boys told me that they had taken it upon themselves to teach 3101 how to care for himself. The results are positive. My hope is that they will be lasting."

Figure 66 shows that student reactions were high across the three rating scales. Figure 67 shows that both activities were considered to be important for EMH students. Eighty-five percent of the teachers estimated that one-half or more of their students were able to perform the behaviors specified by the subobjectives, and they judged the subobjectives to be very important (Figures 68 and 69). Again, it is interesting to note that the teacher who did not follow the strategies reported the lowest success level for her students.

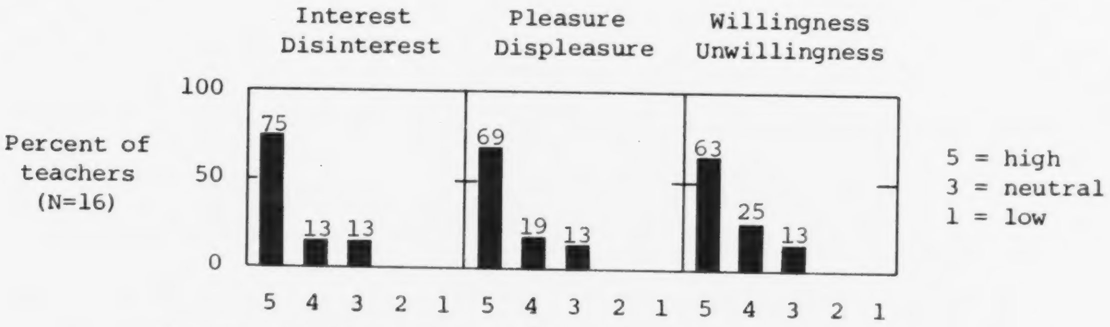


Figure 66. Reaction of the majority of students to activities 12 and 13

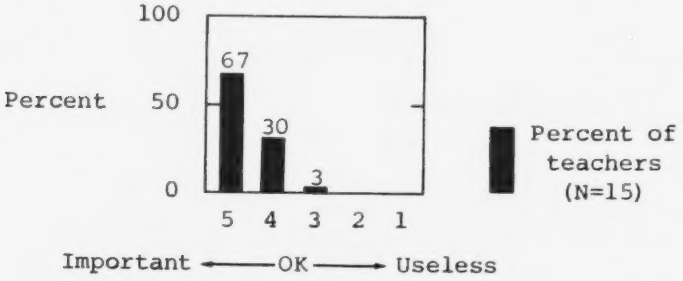


Figure 67. Importance to students of activities 12 and 13

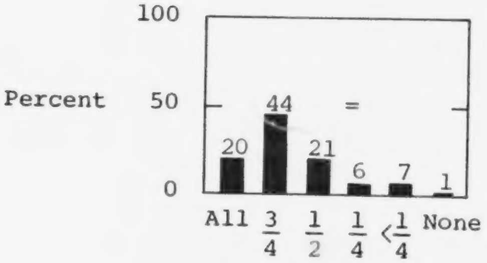


Figure 68. Proportion of students able to perform on subobjectives for activities 12 and 13

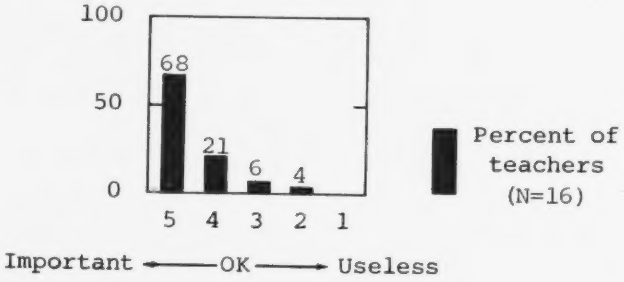


Figure 69. Importance of the subobjectives

For activities 14 and 14a optional, 75 percent of the teachers reported that they used the strategies as described; 25 percent reported some modifications. Three problems were encountered with activities 14 and 14a. First, too much subject matter is contained in activity 14. This has been split up into three different activities in the revised materials. Second, the kidney model made from the tin can was troublesome for some teachers, but refinements have been made and the model now works very well. Third, the colored dots on the daylight slides representing urine, blood, etc. were difficult to distinguish by some students. The dots have now been changed to triangles and more vivid colors have been used. The success of optional activity 14a (dissecting a real kidney) has led to the inclusion of this as a regular activity. A review activity has been added to help the students better understand the "gestalt" of this series of activities. The functioning torso that is available with the commercial edition will greatly enhance not only these activities, but the entire instructional sequence.

One teacher's comment should be included here: "Children are very proud of their attitude toward science. We have not had any problems with embarrassment over bodily functions in this unit. Their interest in showing others the new vocabulary they are learning has prompted the use of appropriate terminology rather than slang terms."

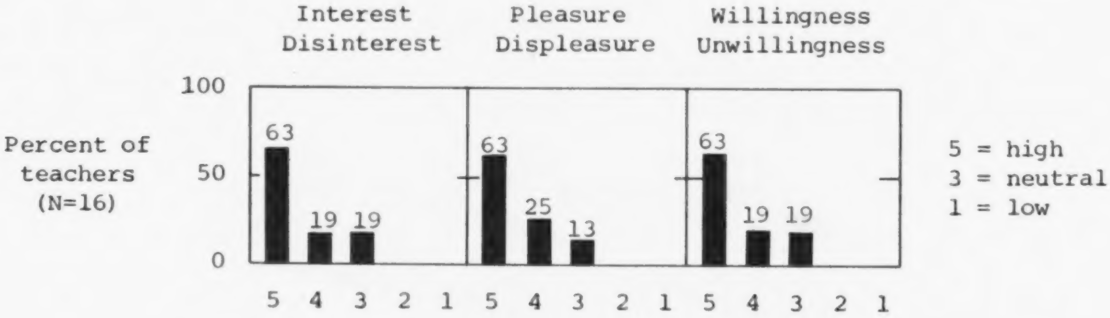


Figure 70. Reaction of the majority of students to activities 14 and 14a.

Figure 70 shows that students reactions were high across the three rating scales. Figure 71 shows that both activities were considered to be important for EMH students. Sixty-four percent of the teachers

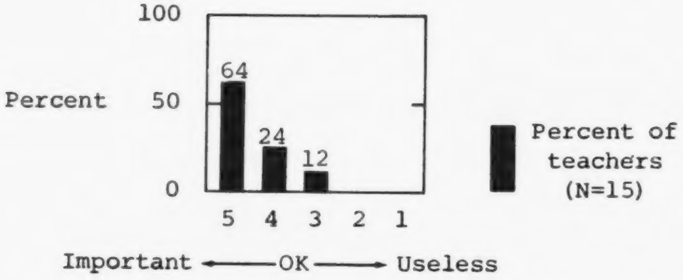


Figure 71. Importance to students of activities 14 and 14a

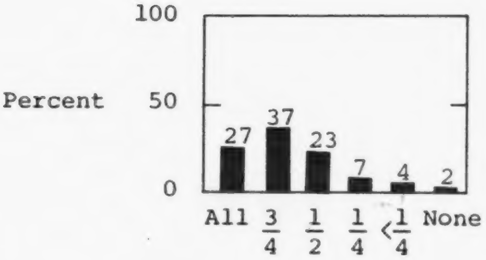


Figure 72. Proportion of students able to perform on subobjectives for activities 14 and 14a

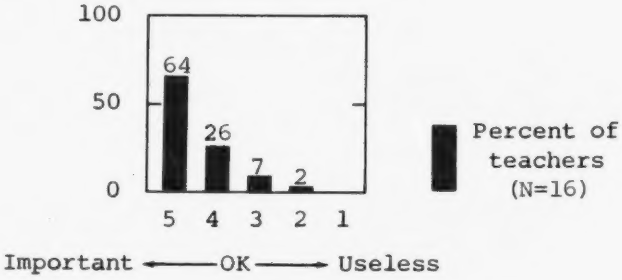


Figure 73. Importance of the subobjectives

estimated that three-fourths or more of their students were able to perform the behaviors specified by the subobjectives; 87 percent estimated that one-half or more of their students could perform successfully (see Figure 72). Figure 73 shows that the objectives were considered to be important.

For activity 15, 75 percent of the teachers reported that they used the strategies as prescribed; 25 percent reported some modifications. Seventy-five percent reported that the strategies were successful. Some minor problems were encountered in interpreting the slides of the skin cross-section, but most were overcome by student-teacher dialogue. The application extensions to the activities continue to prove very effective, as is clear from the following feedback: "The discussions relating to the hygienic aspects were lengthy, rewarding and involved all the children. The kids always like to apply knowledge gained from the 'scientific' approach and relate their personal experiences. By the way -- #3101 shows great improvement in his personal hygiene and I attribute much of this gain to our study. This -- coupled with peer influence (pressure) is paying off.

"On the day we were using this activity a boy 'skinned' his knee. He peeled off some loose skin and it was a perfect example. I would not recommend it as a prescribed procedure -- but the coincidence was great and good therapy for the victim."

Figure 74 shows that student reactions were high across the three rating scales. Figure 75 shows that activity 15 was considered extremely important for EMH students. Figure 76 shows that 58 percent of the teachers estimated that three-fourths or more of their students could successfully perform the behaviors specified; 80 percent reported that

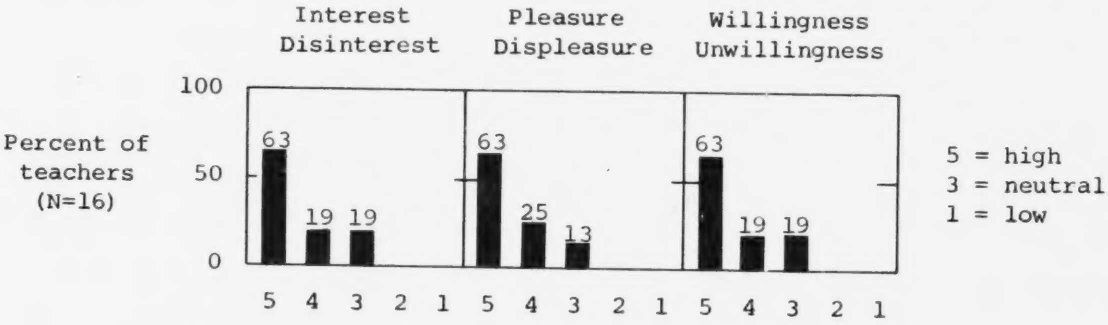


Figure 74. Reaction of the majority of students to activity 15

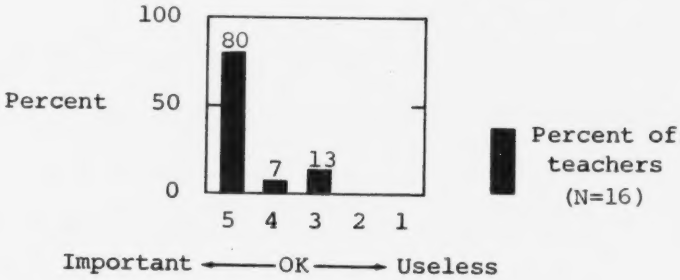


Figure 75. Importance to students of activity 15

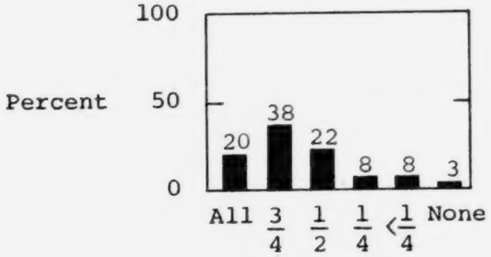


Figure 76. Proportion of students able to perform on subobjectives for activity 15

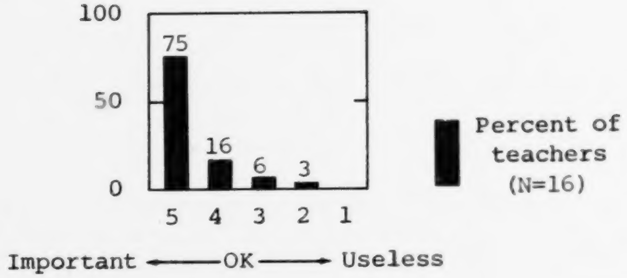
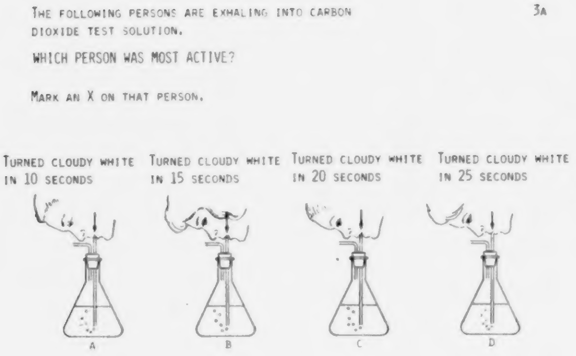


Figure 77. Importance of the subobjectives

one-half or more of their students were successful. Figure 77 shows that the subobjectives were also judged to be very important.

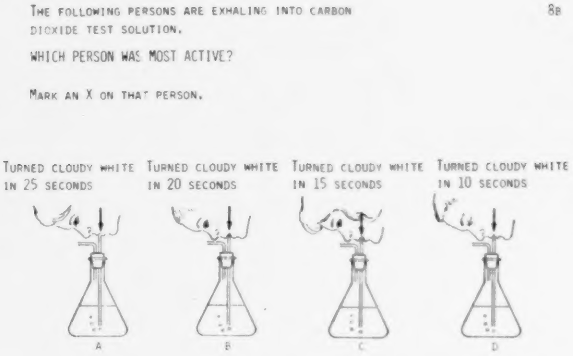
Eight item pairs were designed to assess achievement on objective 202.


THE FOLLOWING PERSONS ARE EXHALING INTO CARBON DIOXIDE TEST SOLUTION.

WHICH PERSON WAS MOST ACTIVE?

MARK AN X ON THAT PERSON.

3A
TURNED CLOUDY WHITE IN 10 SECONDS
TURNED CLOUDY WHITE IN 15 SECONDS
TURNED CLOUDY WHITE IN 20 SECONDS
TURNED CLOUDY WHITE IN 25 SECONDS
A
B
C
D


THE FOLLOWING PERSONS ARE EXHALING INTO CARBON DIOXIDE TEST SOLUTION.

WHICH PERSON WAS MOST ACTIVE?

MARK AN X ON THAT PERSON.

8B
TURNED CLOUDY WHITE IN 25 SECONDS
TURNED CLOUDY WHITE IN 20 SECONDS
TURNED CLOUDY WHITE IN 15 SECONDS
TURNED CLOUDY WHITE IN 10 SECONDS
A
B
C
D

Item pair 3-A, 8-B functions at the cognitive level of analysis. Mean net gain from pretest to posttest for the experimental group was 12 percent (from 28 to 40 percent). This gain resulted from losses from all distractor pairs except D on Form A and A on Form B, where gains of four percent each were recorded. It is evident from these results that some students are having problems relating the time

Table 124. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	3-A	79	30	22	18	30	0	0	95	42	17	7	34	0	0	.41	.35
	8-B	95	37	19	17	27	0	0	79	41	13	8	38	1	0	.16	.69
Control	3-A	80	25	9	11	53	3	0	89	34	13	11	40	0	1	.22	.59
	8-B	89	45	11	16	27	1	0	80	41	11	8	40	0	0	.29	.29

Table 125. Pretest to Posttest Changes
(The response choice for 3-A is cited first.)

Item Pair 3-A, 8-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	D	A+D	B	C	B+C	C	B	C+B	D	A	D+A
Experi-mental	+12	+11	+12	-5	-9	-6	-11	-6	-9	+4	+4	+3
Control	+9	+13	+11	+4	-8	-2	0	0	0	-13	-4	-9

elapsed with carbon dioxide content of the breath. The three modifications mentioned earlier should rectify this problem: counting breaths instead of time, separating oxygen and carbon dioxide test worksheets, and separating the testing activities on different days with a strengthened review at the end of the activities. Mean net gain for the control group was 11 percent (from 26 to 37 percent), which is very similar to the achievement levels of the experimental group. Biserial correlations for both the experimental and control groups improved from pretest to posttest which, together with achievement levels, led us to hypothesize that instruction on this topic occurred within the control group.

Item pair 4-A, 6-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 38 percent (from 14 to 52 percent). This gain can be accounted for by

THE BLADDER IS USED FOR: HOLDING, CLEANING, PUMPING, MIXING? 4A

MARK AN X ON YOUR CHOICE.

HOLDING	CLEANING	PUMPING	MIXING
A	B	C	D

THE BLADDER IS USED AS A: PUMP, MIXER, HOLDER, CLEANER? 6B

MARK AN X ON YOUR CHOICE.

PUMP	MIXER	HOLDER	CLEANER
A	B	C	D

Table 126. Item Responses and Biserial Correlations for Experimental and Control Groups

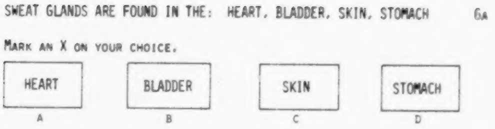
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	4-A	79	13	19	37	32	0	0	95	42	22	19	17	0	0	.29	.71
	6-B	95	42	20	15	23	0	0	79	18	8	62	11	1	0	-.09	.60
Control	4-A	80	14	20	40	26	0	0	89	29	17	40	10	2	1	.40	.61
	6-B	89	33	11	28	27	1	0	80	33	14	28	25	1	0	.13	.74

Table 127. Pretest to Posttest Changes
(The response choice for 4-A is cited first.)

Item Pair 4-A, 6-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	D	B+D	C	A	C+A	D	B	D+B
Experi-mental	+29	+47	+38	+3	-12	-4	-18	-24	-21	-15	-12	-13
Control	+15	0	+8	-3	-2	-3	0	0	+1	-16	+3	-6

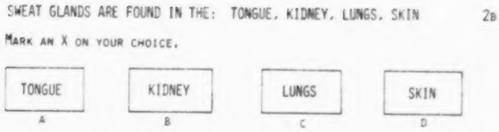
losses on all other response choices. Mean total gain for the control group was eight percent (from 21 to 29 percent). Substantial improvement in biserial correlations from pretest to posttest and the excellent gains in the experimental group mean scores enable us to attribute these gains to the effect of instruction.

Item pair 6-A, 2-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 20 percent (from 60 to 80 percent) and can be accounted for by losses on all other response choices. Mean net gain for the control group


SWEAT GLANDS ARE FOUND IN THE: HEART, BLADDER, SKIN, STOMACH 6A

MARK AN X ON YOUR CHOICE.

HEART	BLADDER	SKIN	STOMACH
A	B	C	D


SWEAT GLANDS ARE FOUND IN THE: TONGUE, KIDNEY, LUNGS, SKIN 2B

MARK AN X ON YOUR CHOICE.

TONGUE	KIDNEY	LUNGS	SKIN
A	B	C	D

was four percent (from 61 to 65 percent), enabling us to attribute experimental group gains to the effect of instruction. Improvements in biserial correlations from pretest to posttest add credence to this decision.

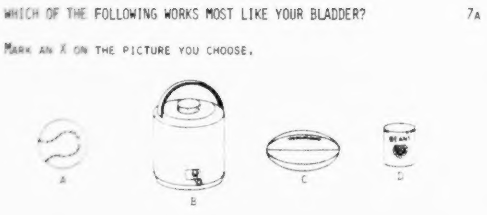
Table 128. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	6-A	79	5	15	63	16	0	0	95	3	9	83	4	0	0	.25	.62
	2-B	95	12	12	18	58	1	0	79	6	9	9	76	0	0	.46	.84
Control	6-A	80	8	10	70	11	0	1	89	9	9	60	21	0	1	.45	.61
	2-B	89	8	18	22	52	0	0	80	6	10	13	70	1	0	.27	.56

Table 129. Pretest to Posttest Changes (The response choice for 6-A is cited first.)

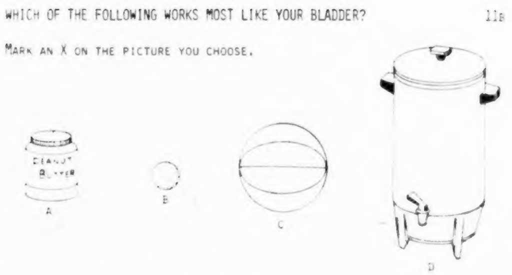
Item Pair 6-A, 2-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	D	C+D	A	C	A+C	B	B	B+B	D	A	D+A
Experi-mental	+20	+18	+20	-2	-9	-6	-6	-3	-4	-12	-6	-9
Control	-10	+18	+4	+1	-9	-4	-1	-8	-5	+10	-2	+5

Item pair 7-A, 11-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 13 percent (from 72 to 85 percent). Mean net gain for the control group was five percent (from 68 to 73 percent). The experimental group gains were very encouraging and were attributed to the



WHICH OF THE FOLLOWING WORKS MOST LIKE YOUR BLADDER?

MARK AN X ON THE PICTURE YOU CHOOSE.



WHICH OF THE FOLLOWING WORKS MOST LIKE YOUR BLADDER?

MARK AN X ON THE PICTURE YOU CHOOSE.

effect of instruction. Biserial correlations for both the experimental and control groups were excellent.

Table 130. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	7-A	79	9	76	10	4	1	0	95	4	85	4	6	0	0	.53	.35
	11-B	95	9	8	12	69	1	0	79	0	0	15	85	0	0	.27	.37
Control	7-A	80	8	70	11	10	1	0	89	2	75	10	10	1	1	.50	.59
	11-B	89	9	7	17	65	2	0	80	8	3	19	71	0	0	.44	.63

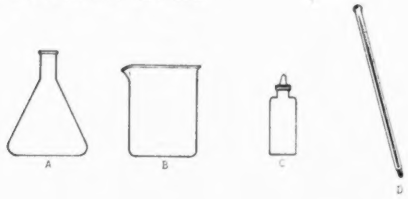
Table 131. Pretest to Posttest Changes (The response choice for 7-A is cited first.)

Item Pair 7-A, 11-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	D	B+D	A	B	A+B	C	C	C+C	D	A	D+A
Experi-mental	+9	+16	+13	-5	-8	-6	-6	+3	-2	+2	-9	-4
Control	+5	+6	+5	-6	-4	-5	-1	+2	0	0	-1	0

Item pair 14-A, 9-B functions at the cognitive level of comprehension. There was a mean net loss of two percent (from 63 to 61 percent) from pretest to posttest for the experimental group. The reason for this is that this pair of items was geared to an activity that has been removed from the instructional sequence. There was a mean net

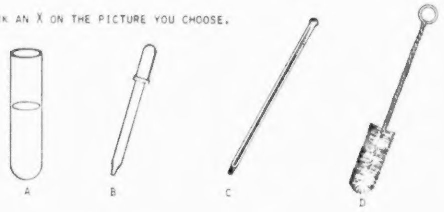
WHAT WOULD YOU USE TO FIND OUT IF ENERGY WAS GIVEN OFF FROM YOUR MUSCLE? 14A

MARK AN X ON THE PICTURE YOU CHOOSE.



WHAT WOULD YOU USE TO FIND OUT IF ENERGY WAS GIVEN OFF FROM YOUR MUSCLE? 9B

MARK AN X ON THE PICTURE YOU CHOOSE.



gain of eight percent (from 60 to 68 percent) for the control group. Pretest levels indicate that approximately two-thirds of the students in our sample understand the relationship between energy and heat.

Table 132. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	14-A	79	6	6	16	71	0	0	95	23	6	9	61	0	0	.38	.31
	9-B	95	21	19	55	5	0	0	79	19	16	62	3	0	0	.26	.41
Control	14-A	80	14	11	13	63	0	0	89	10	7	10	71	0	0	.44	.54
	9-B	89	20	17	56	6	1	0	80	18	16	65	1	0	0	.36	.53

Table 133. Pretest to Posttest Changes (The response choice for 14-A is cited first.)

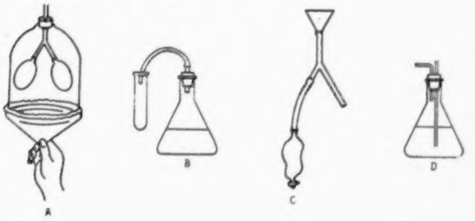
Item Pair 14-A, 9-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	C	D+C	A*	D*	A+D	B	A	B+A	C	B	C+B
Experi-mental	-10	+7	-2	+17	-2	+8	0	-2	-2	-7	-3	-6
Control	+8	+9	+8	-4	-5	-4	-4	-2	-4	-3	-1	-2

*A and D are not parallel distractors.

Item pair 21-A, 25-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 20 percent (from 49 to 69 percent). Mean total gain for the

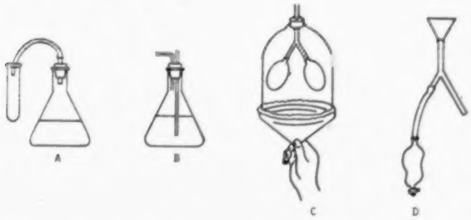
WHICH MODEL SHOWS HOW YOUR BODY GETS RID OF URINE? 21A

MARK AN X ON YOUR CHOICE.



WHICH MODEL SHOWS HOW YOUR BODY TAKES IN AIR? 25B

MARK AN X ON YOUR CHOICE.



control group was six percent (from 42 to 48 percent), enabling us to attribute experimental group gains to the effect of instruction. Success on this pair of items should be even greater when the materials are used with the functioning human torso that was not available for the test trials covered in this report. Biserial correlations for the experimental group indicate that both items are good discriminators.

Table 134. Item Responses and Biserial Correlations
for Experimental and Control Groups

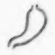
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	21-A	79	5	20	66	8	1	0	95	3	26	68	2	0	0	.49	.31
	25-B	95	9	6	35	49	0	0	79	5	14	71	9	1	0	.46	.40
Control	21-A	80	15	30	50	5	0	0	89	4	29	47	17	1	1	.23	.04
	25-B	89	10	11	36	42	1	0	80	5	8	49	39	0	0	.39	.31

Table 135. Pretest to Posttest Changes
(The response choice for 21-A is cited first.)

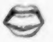
Item Pair 21-A, 25-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	D	A+D	B	A	B+A	D	B	D+B
Experimental	+2	+36	+20	-2	-40	-21	+6	-4	+2	-6	+8	+1
Control	-3	+13	+6	-11	-3	-8	-1	-5	-3	+12	-3	+5

A SWEAT GLAND ACTS MOST LIKE WHICH OF THE FOLLOWING: 25A

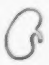
MARK AN X ON THE PICTURE YOU CHOOSE.



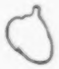
STOMACH
A



MOUTH
B



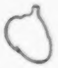
KIDNEY
C



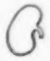
HEART
D

A SWEAT GLAND ACTS MOST LIKE WHICH OF THE FOLLOWING: 29B

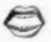
MARK AN X ON THE PICTURE YOU CHOOSE.



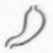
HEART
A



KIDNEY
B



MOUTH
C



STOMACH
D

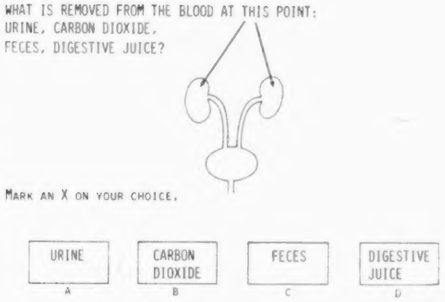
Item pair 25-A, 29-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was seven percent (from 34 to 41 percent). Although gains were made, the relatively low achievement level confirmed teacher reports that students were having problems understanding the slides used in these activities. Artwork has been improved and simplified and the activity has been strengthened, all of which should improve student performance. Mean total gain for the control group was four percent. Biserial correlations indicate that the experimental group taking pretest A and posttest B performed much better on this item pair than did the pretest B-posttest A group, which confirms reports received from the teachers.

Table 136. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	25-A	79	18	29	35	15	3	0	95	11	43	39	7	0	0	.16	-.01
	29-B	95	16	34	39	12	0	0	79	13	44	28	14	1	0	.01	.22
Control	25-A	80	24	25	29	23	0	0	89	9	16	34	39	1	1	.01	.37
	29-B	89	26	22	27	21	2	1	80	21	23	29	28	0	0	.15	.30

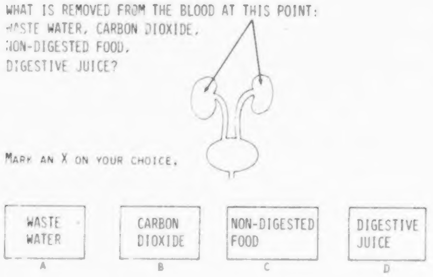
Table 137. Pretest to Posttest Changes
(The response choice for 25-A is cited first.)

Item Pair 25-A, 29-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	D	A+D	B	C	B+C	D	A	D+A
Experi-mental	+4	+10	+7	-7	+2	-3	+14	-9	+2	-8	-3	-6
Control	+5	+1	+4	-15	+7	-4	-9	+2	-4	+16	-5	+5


WHAT IS REMOVED FROM THE BLOOD AT THIS POINT:
URINE, CARBON DIOXIDE,
FECES, DIGESTIVE JUICE?

MARK AN X ON YOUR CHOICE.

29A


WHAT IS REMOVED FROM THE BLOOD AT THIS POINT:
WASTE WATER, CARBON DIOXIDE,
NON-DIGESTED FOOD,
DIGESTIVE JUICE?

MARK AN X ON YOUR CHOICE.

20B

Item pair 29-A, 20-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 27 percent (from 15 to 42 percent) which can be accounted for by losses from all distractors except carbon dioxide, which had a mean total gain of five percent (from 18 to 23 percent). Total gains for the experimental group were excellent, but it is evident that some confusion still exists between the functions of the lung and kidney. We feel strongly that the improved slides, functioning torso and films that will be available with the commercial materials will alleviate this problem. The mean net loss of one percent (from 15 to 14 percent) for the control group indicates an important gain is attributable to the effect of instruction in the experimental group. Biserial correlations were exceptionally good for the experimental group.

Table 138. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	29-A	79	10	24	47	16	3	0	95	37	23	25	15	0	0	.40	.71
	20-B	95	20	13	33	33	2	0	79	48	23	20	6	3	0	.52	.40
Control	29-A	80	6	23	33	33	6	0	89	13	25	25	34	2	1	.25	.35
	20-B	89	24	22	33	18	3	0	80	15	15	36	29	4	0	.24	.20

Table 139. Pretest to Posttest Changes
(The response choice for 29-A is cited first.)

Item Pair 29-A, 20-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experi-mental	+27	+28	+27	-1	+10	+5	-22	-13	-17	-1	-27	-15
Control	+7	-9	-1	+2	-7	-2	-8	+5	-2	+1	+11	+7

Objective 203. Students will recognize, recall and be able to synthesize concepts presented in this unit. One student activity and other instructional strategies were designed to develop student competencies to achieve this objective.

For activity 16, 94 percent of the teachers reported that they used the strategies as prescribed; six percent reported some modification. Ninety-four percent reported that the strategies were successful. Some minor problems of reception were encountered with the colors used in the slides, but modifications should eliminate this problem entirely.

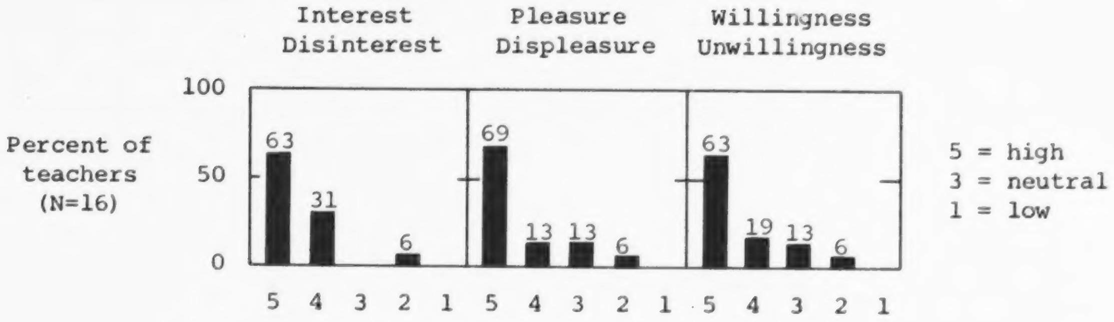


Figure 78. Reaction of the majority of students to activity 16

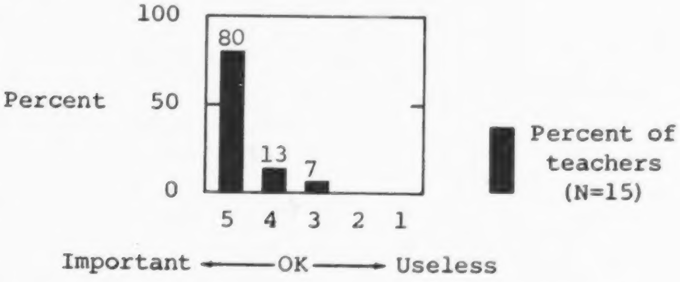


Figure 79. Importance to students of activity 16

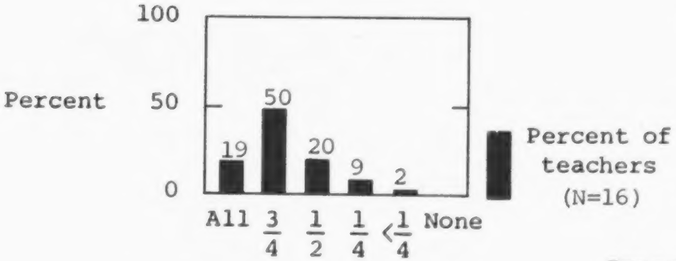


Figure 80. Proportion of students able to perform on subobjectives for activity 16

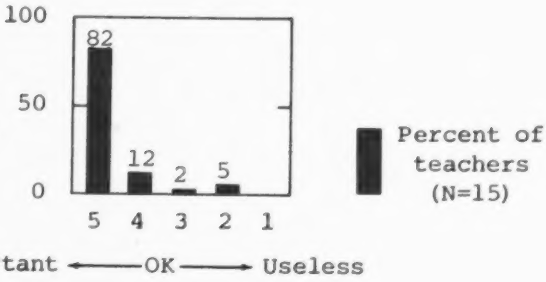
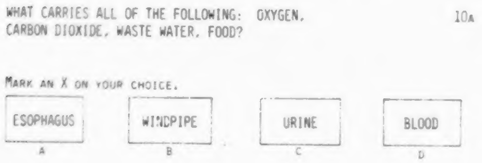


Figure 81. Importance of the subobjectives

Figure 78 shows that student reactions were quite high across the three rating scales. Figure 79 shows that teachers considered the activity to be important, and Figure 80 shows that 69 percent of the teachers reported that three-fourths or more of their students could successfully perform the behaviors prescribed in the subobjectives of objective 203. Eighty-nine percent reported that one-half or more of their students were successful. Figure 81 shows that teachers considered the subobjectives to be very important.

Three item pairs were designed to assess student achievement on objective 203.


WHAT CARRIES ALL OF THE FOLLOWING: OXYGEN, CARBON DIOXIDE, WASTE WATER, FOOD?

10A

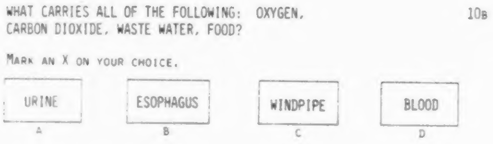
MARK AN X ON YOUR CHOICE.

ESOPHAGUS A

WINDPIPE B

URINE C

BLOOD D


WHAT CARRIES ALL OF THE FOLLOWING: OXYGEN, CARBON DIOXIDE, WASTE WATER, FOOD?

10B

MARK AN X ON YOUR CHOICE.

URINE A

ESOPHAGUS B

WINDPIPE C

BLOOD D

Item pair 10-A, 10-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was 25 percent (from 47 to 72 percent). This gain can be accounted for by losses from all other response choices. Mean total gain for the control group was 12 percent (from 34 to 46 percent). These results clearly indicate that the experimental group gains can be attributed to the effect of instruction. Biserial correlations for both the experimental and control groups are excellent. It is evident from this item that approximately three-fourths of the students understand the distributive function of the blood.

Table 140. Item Responses and Biserial Correlations for Experimental and Control Groups

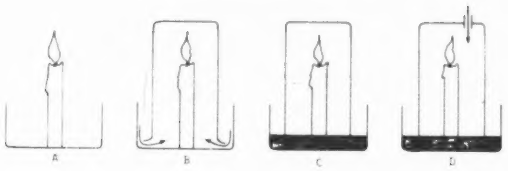
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	10-A	79	20	15	24	39	1	0	95	8	14	11	67	0	0	.06	.54
	10-B	95	12	17	17	55	0	0	79	3	8	11	78	0	0	.19	.65
Control	10-A	80	28	28	13	33	0	0	89	16	19	16	47	1	1	.21	.54
	10-B	89	10	19	37	34	0	0	80	6	23	25	45	1	0	.21	.35

Table 141. Pretest to Posttest Changes
(The response choice for 10-A is cited first.)

Item Pair 10-A, 10-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	B	A+B	B	C	B+C	C	A	C+A
Experimental	+28	+23	+25	-12	-9	-10	-1	-6	-3	-13	-9	-11
Control	+14	+11	+12	-12	+4	-4	-9	-12	-11	+3	-4	0

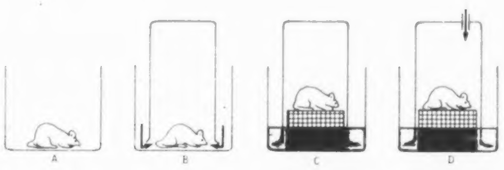
WHICH OF THE CANDLES WOULD GO OUT FIRST? 20A

MARK AN X ON THE PICTURE.



WHICH MOUSE WILL DIE FIRST? 21B

MARK AN X ON THE PICTURE.



Item pair 20-A, 21-B functions at the cognitive level of analysis. Mean total gain from pretest to posttest for the experimental group was 22 percent (from 37 to 59 percent). These gains can be accounted for by losses on all other response choices, except response choice D, where gains were made on Form B. Mean total gain for the control group was 17 percent (from 30 to 47 percent). Student achievement on this item is outstanding considering the complex cognitive processes involved. The gain from pretest to posttest can clearly be attributed to the effect of instruction. Biserial correlations for the posttests for both experimental and control groups were very high.

Table 142. Item Responses and Biserial Correlations for Experimental and Control Groups

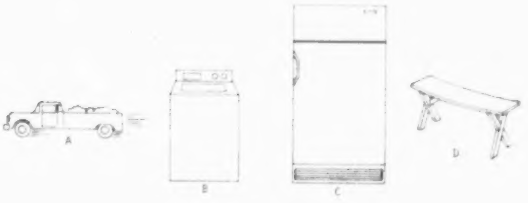
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	20-A	79	27	1	41	32	0	0	95	1	4	68	26	0	0	.32	.43
	21-B	95	22	22	33	23	0	0	79	5	3	49	43	0	0	.52	.49
Control	20-A	80	31	9	39	20	1	0	89	16	8	48	28	0	1	.26	.51
	21-B	89	38	15	21	26	0	0	80	24	11	45	20	0	0	.26	.49

Table 143. Pretest to Posttest Changes (The response choice for 20-A is cited first.)

Item Pair 20-A, 21-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experi-mental	+27	+16	+22	-26	-17	-21	+3	-19	-8	-6	+20	+7
Control	+9	+24	+17	-15	-14	-15	-1	-4	-3	+8	-6	+1

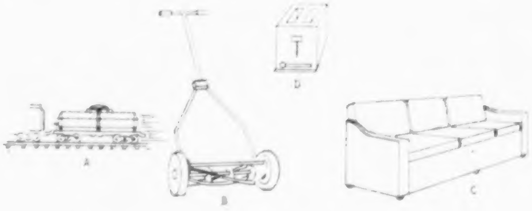
WHICH OF THE FOLLOWING ACTS MOST LIKE THE BLOOD? 27A

MARK AN X ON THE PICTURE YOU CHOOSE.



WHICH OF THE FOLLOWING ACTS MOST LIKE THE BLOOD? 16B

MARK AN X ON THE PICTURE YOU CHOOSE.



Item pair 27-A, 16-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was 16 percent (from 62 to 78 percent). The gains can be accounted for by losses on all other response choices. Mean total gain for the control group was eight percent (from 59 to 67 percent), enabling us to attribute the experimental group gains to the effect of instruction. This item pair and the previous two item pairs were designed to assess student achievement on summary items, and experimental group achievement here is encouraging, especially in view of the cognitive processes involved. Biserial correlations for both pretests and posttests indicate that this item pair is discriminating between high and low scoring students.

Table 144. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	27-A	79	51	35	13	0	1	0	95	69	24	6	0	0	0	.27	.60
	16-B	95	73	14	0	14	0	0	79	87	8	0	5	0	0	.54	.65
Control	27-A	80	43	43	11	4	0	0	89	64	20	13	1	0	1	.22	.37
	16-B	89	74	15	1	7	3	0	80	71	11	1	16	0	0	.59	.40

Table 145. Pretest to Posttest Changes
(The response choice for 27-A is cited first.)

Item Pair 27-A, 16-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experimental	+18	+14	+16	-11	-6	-8	-7	0	-3	0	-9	-5
Control	+21	-3	+12	-23	-4	-13	+2	0	+1	-3	+9	+2

Objective Achievement Tests

Descriptive Data and Interpretation. Pretests were administered to experimental classes between January 5 and March 2, 1971 and to control classes between January 7 and 19, 1971. As was the case with Unit I, differences in the amount of time devoted to science instruction caused a wide difference in posttest administration dates within the experimental group. The earliest was February 1, 1971 and the latest was March 31, 1971. Control group posttests were administered between February 10 and March 15, 1971.

Raw score frequency distributions on the tests for both experimental and control groups are shown in Table 146. Tables 147 and 148 provide more detailed descriptive data on pretest and posttest scores and on residual gain scores, calculated with the raw regression coefficient for the combined experimental and control classes. The interpretations that follow are based upon the data provided in these tables.

1. Experimental classes using pretest Form A had similar pretest means, within the standard error of measurement. Experimental classes using pretest Form B registered means outside the range of the standard error of measurement, indicating different levels of student knowledge prior to instruction in Unit II. This result indicates that covariance analysis with pretest and posttest scores and/or analysis of variance using residual gain scores will be necessary for any comparisons of student achievement among experimental classes.
2. Posttest means for Forms A and B were also outside of the standard error of measurement, but posttest reliabilities were above the

Table 146. Frequency Distribution of Raw Scores for Test Forms A and B, Experimental and Control Groups

	Experimental Groups				Control Groups			
Raw Scores	Pre A	Post B	Pre B	Post A	Pre A	Post B	Pre B	Post A
30								
28-29				1				
26-27		4		4				
24-25		9	1	9		2		2
22-23	1	14	4	7		4		4
20-21	1	12	2	8	1	9	3	2
18-19	7	10	5	13	5	5	4	10
16-17	15	6	9	26	17	13	12	11
14-15	19	12	20	11	16	11	24	15
12-13	14	6	23	10	19	17	21	30
10-11	15	3	14	5	14	7	13	6
8-9	5	1	15		6	10	6	6
6-7	1	2	2	1	2	2	4	1
4-5							2	
2-3	1							1
0-1								1
Totals	79	79	95	95	80	80	89	89

minimum acceptable level of .70. Fifteen of 16 experimental classes showed positive mean residual gain scores and the one negative score was not seriously low. A multiple stepwise regression was performed to determine the effects of the independent variables on posttest scores. Analysis of variance on residual gain scores was also performed to confirm the results of the covariance analysis.

3. Means for control classes using pretest Form B were within the limits of the standard error of measurement but those using pretest

Table 147. Experimental Group Pretest, Posttest, and Residual Gain Data
Unit II, *ME NOW*, Respiration and Excretion

	PRETEST							POSTTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range	
																	Min.	Max.
Form A 21	5	13.00	43.33	3.67		1.64	9-17	16.20	54.00	7.66		3.43	7-24	0.14	5.41	2.42	-7.57	5.70
22	10	13.20	44.00	3.33		1.05	8-20	18.80	62.66	5.59		1.77	8-26	2.59	3.96	1.25	-4.34	9.19
23	12	14.58	48.60	2.11		0.61	11-18	18.25	60.83	3.82		1.10	13-23	1.01	3.22	0.93	-3.55	5.68
24	11	12.73	42.43	3.41		1.03	7-19	14.64	48.80	3.70		1.11	11-21	-1.22	4.10	1.24	-6.30	5.17
25	10	14.10	47.00	2.38		0.75	11-17	21.00	70.00	4.16		1.32	13-26	4.12	3.47	1.10	-3.81	7.70
26	13	13.85	46.16	3.69		1.02	8-19	22.15	73.83	2.19		0.61	17-25	5.46	3.20	0.89	1.21	10.43
27	10	13.50	45.00	4.93		1.56	2-19	17.30	57.66	4.19		1.33	7-23	0.86	2.41	0.76	-1.81	5.92
28	8	15.00	50.00	4.00		1.41	10-22	19.63	65.43	4.24		1.50	13-26	2.07	2.78	0.98	-0.83	5.94
All A	79	13.77	45.90	3.40	0.51	2.34*	2-22	18.70	62.33	4.75	0.77	2.26*	7-26	2.06	3.98	0.45	-7.57	10.43
Form B 31	9	12.89	42.96	3.69		1.23	8-21	21.00	70.00	4.69		1.56	11-26	5.02	3.19	1.06	-1.34	8.94
32	12	11.08	36.93	2.31		0.67	8-15	15.42	51.40	3.87		1.12	10-24	0.78	3.39	0.98	-5.55	7.19
33	11	16.55	55.16	4.99		1.50	8-24	19.36	64.53	4.37		1.32	13-27	0.66	2.46	0.74	-3.26	4.70
34	13	14.46	48.20	2.70		0.75	9-19	18.77	62.56	4.09		1.13	14-27	1.61	3.22	0.89	-4.30	6.47
35	11	10.55	35.16	3.08		0.93	8-17	16.00	53.33	3.46		1.04	11-24	1.76	3.84	1.16	-5.04	8.68
36	11	15.64	52.13	3.93		1.19	10-23	20.09	66.96	3.88		1.17	15-28	2.06	2.82	0.85	-4.04	5.98
37	15	12.47	41.56	3.80		0.98	16-22	16.07	53.56	3.22		0.83	11-23	0.40	2.46	0.64	-3.81	4.66
38	13	12.69	42.30	2.72		0.75	7-17	16.85	56.16	5.44		1.51	7-25	1.01	4.44	1.23	-4.59	7.94
All B	95	13.25	44.16	3.85	0.59	2.43*	6-24	17.77	59.23	4.44	0.73	2.25*	7-28	1.52	3.41	0.35	-5.55	8.94
All	174	13.49	44.96	3.66		0.28	2-24	18.19	60.63	4.59		0.35	7-28	1.76	3.68	0.28	-7.57	10.43
Boys	116	14.01	46.70	3.85		0.36	2-24	19.03	63.43	4.70		0.44	7-28	2.22	3.77	0.35	-7.57	10.43
Girls	58	12.45	41.50	3.00		0.39	7-19	16.50	55.00	3.89		0.51	7-24	0.85	3.34	0.44	-6.30	7.43

*Standard error of estimate (σ_s) for individual scores.

Table 148. Control Group Pretest, Posttest, and Residual Gain Data Unit II, *ME NOW*, Respiration and Excretion

	PRETEST							POSTTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range	
																	Min.	Max.
Form A 81	11	10.18	33.93	1.99		0.60	7-14	9.73	32.43	2.33		0.70	6-15	-4.24	2.49	0.75	-7.81	1.92
82	7	13.71	45.70	3.59		1.36	9-18	14.00	46.66	3.79		1.43	9-18	-2.60	3.36	1.27	-6.04	2.43
83	12	12.25	40.83	2.67		0.77	7-17	14.25	47.50	4.45		1.29	7-21	-1.25	3.76	1.09	-7.81	5.43
84	12	16.58	55.26	2.50		0.72	12-21	20.17	67.23	4.06		1.17	11-24	1.43	3.05	0.88	-5.06	4.96
85	8	15.13	50.43	2.80		0.99	10-19	16.63	55.43	2.97		1.05	12-21	-1.02	3.88	1.37	-6.04	4.17
86	9	13.78	45.93	2.54		0.85	10-17	13.78	45.93	3.70		1.23	8-21	-2.87	3.40	1.13	-8.06	2.70
87	11	14.55	48.50	1.04		0.31	13-16	15.45	51.50	3.21		0.97	12-21	-1.76	3.20	0.96	-5.55	4.19
88	10	12.20	40.66	2.04		0.65	8-16	13.60	45.33	1.84		0.58	11-16	-1.87	2.18	0.69	-6.30	0.66
All A	80	13.51	45.03	3.03	0.42	2.27*	7-21	14.76	49.20	4.41	0.71	2.34*	6-24	-1.68	3.46	0.39	-8.06	5.43
Form B 91	13	14.77	49.23	3.35		0.93	9-20	19.85	66.16	3.69		1.02	12-25	2.46	3.53	0.98	-4.81	6.68
92	7	14.29	47.63	1.25		0.47	12-16	14.29	47.63	3.40		1.29	8-18	-2.74	3.22	1.22	-8.81	1.19
93	10	12.50	41.66	3.06		0.97	9-18	15.80	52.66	2.82		0.89	12-19	0.11	2.75	0.87	-3.32	5.17
94	11	11.18	37.26	3.34		1.01	5-16	11.54	38.46	4.13		1.25	2-18	-3.16	3.73	1.12	-9.59	1.19
95	8	13.00	43.33	4.00		1.41	4-17	11.75	39.16	5.60		1.98	0-19	-4.31	3.06	1.08	-9.36	-0.04
96	10	13.40	44.66	3.44		1.09	8-18	13.80	46.00	2.97		0.94	9-20	-2.56	2.88	0.91	-6.79	0.96
97	15	13.60	45.33	3.27		0.84	7-20	13.60	45.33	2.38		0.62	10-18	-2.91	3.03	0.78	-9.28	1.41
98	15	12.27	40.90	3.41		0.88	6-18	12.60	42.00	2.92		0.75	7-18	-2.92	3.40	0.88	-7.81	3.41
All B	89	13.10	43.66	3.33	0.46	2.40*	4-20	14.25	47.50	4.24	0.69	2.31*	0-25	-1.89	3.76	0.40	-9.59	6.68
All	169	13.30	44.33	3.19		0.25	4-21	14.49	48.30	4.32		0.33	0-25	-1.79	3.61	0.28	-9.59	6.68
Boys	102	13.32	44.40	3.18		0.31	4-20	14.58	48.60	4.37		0.43	0-25	-1.73	3.61	0.36	-9.36	5.94
Girls	67	13.25	44.16	3.23		0.39	6-21	14.36	47.86	4.27		0.52	2-23	-1.89	3.62	0.44	-9.59	6.68

*Standard error of estimate (σ_s) for individual scores.

Form A were not, indicating different levels of knowledge at the time of pretesting.

4. Posttest means for control classes were outside the limits of the standard error of measurement for both Form A and Form B. This result together with positive mean residual gain scores for classes 91 and 93 and the high gains on some test items, indicate that instruction probably took place in these classes between pretesting and posttesting. This eliminates the possibility of using control classes to compute a test-retest reliability for Unit II. An examination of the control group test score frequence distribution (see Table 146), also indicates small upward shifts.

Multiple Stepwise Regression Analysis

Experimental Group, Unit II. To determine the effect of the independent variables on posttest scores, the following question was investigated: "Is there a significant difference in the level of achievement on the posttest among students in EMH classes having different background variables?"

The following independent variables were used to test this question: sex, age, WISC Full Scale IQ, race, teacher's assessment of reading achievement, teacher's assessment of verbal participation, and pretest score. All scores from Form A and Form B were pooled and treated as the results from one test.

The results for the posttest administered to the 174 students in the Unit II experimental group are summarized in Table 149.

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the posttest instrument.

Table 149. Results of Multiple Linear Regression Analysis, Experimental Group, Unit II

Independent Variable	β_i	$S\beta_i$	F
Sex	-1.4771	.5819	6.4424**
Age	0.0169	.0152	1.2352
WISC Total IQ	0.0940	.0242	15.0687***
Race	-0.4357	.4137	1.1087
Reading Achievement	0.4977	.2310	4.6397*
Verbal Participation	-0.3070	.2514	1.4913
Pretest	0.5622	.0848	43.9080***

*Significant at .05 level, $F_{.05(1,166)} = 3.84$

**Significant at .025 level, $F_{.025(1,166)} = 5.02$

***Significant at .001 level, $F_{.001(1,166)} = 10.83$

Discussion

The data indicate that age, race and teacher's assessment of verbal participation are not significant predictors of success on the posttest. WISC Total IQ and the pretest score, however, are highly significant predictors of success on the posttest ($P<.001$). Sex is also a significant predictor ($P<.025$), as is the teacher's assessment of reading ability ($P<.05$). These results are essentially equivalent to those of Unit I -- that is WISC IQ and prior knowledge of the subject matter, as measured by the pretest score, are the best determinants of the level of success on the posttest instrument. It is logical to assume that a student with a high score on a pretest instrument will likewise achieve a high score on a parallel form of the same instrument administered as a posttest after instruction. An analysis of variance on residual gain scores was computed to determine the exact relationship between sex, reading level, IQ and success on the posttest.

The effect of the pretest accounts for approximately 35.8 percent of the variance in the regression equation. This is not as high as the 44.2 percent accounted for in the Unit I testing but is still satisfactory. The combination of pretest and WISC Total IQ account for 41.4 percent of the variance in Unit II, while the same two variables accounted for 48.8 percent in Unit I. The inclusion of all seven independent variables accounts for 45.8 percent of the variance in the regression equation, as contrasted with the 53.5 percent accounted for in Unit I. Both levels are entirely satisfactory, but the question of what accounts for the remaining variance in both units seems puzzling. A likely hypothesis is that the teacher effect plays an extremely important role.

Table 150. Matrix of Correlation Coefficients Experimental Group, Unit II

	Age	Total IQ	Race	Reading Achievement	Verbal Participation	Pretest	Posttest
Sex	-.093	-.128	-.090	.081	-.021	-.202	-.261
Age		-.085	-.259	.166	.023	.317	.246
Total IQ			-.018	.207	.205	.281	.394
Race				-.088	-.185	-.029	-.084
Reading Achievement					.387	.331	.315
Verbal Participation						.237	.149
Pretest							.599

Table 151. Multiple Stepwise Regression Analysis Experimental Group, Unit II

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables
1	Pretest	.5986	.3583	.3583	96.0454	1
2	Total IQ	.6432	.4137	.0554	16.1633	2
3	Sex	.6554	.4295	.0158	4.6936	3
4	Reading Achievement	.6659	.4434	.0139	4.2237	4
5	Age	.6717	.4512	.0078	2.3925	5
6	Verbal Participation	.6743	.4547	.0035	1.0734	6
7	Race	.6770	.4583	.0036	1.1087	7

Analysis of Variance and Covariance Experimental Group

Two different statistical analyses were performed to investigate the question, "Is there a significant difference between experimental classes in the level of achievement on the Unit II posttest?" The results of an analysis of covariance are summarized in Table 152.

Table 152. Analysis of Covariance Between Classes on Adjusted Unit II Posttest Means, Pretest as Covariate

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	34.9766	3.0206**
Within Groups	164	11.5794	

**Significant at .001 level, $F_{.001(15,157)} = 2.51$

These results indicate that significant differences do exist between experimental classes on posttest means adjusted for differences in pretest scores.

Table 153 summarizes the means and standard deviations for pretests and posttests for each class in the experimental group.

Table 153. N, Means, Standard Deviations, and Adjusted Means of 16 Classes Experimental Group, Unit II

Class Number	N	Posttest Mean	Posttest Standard Deviations	Adjusted Posttest Mean	Pretest Mean
21	5	16.20	7.66	16.55	13.00
22	10	18.80	5.59	19.01	13.20
23	12	18.25	3.82	17.46	14.58
24	11	14.64	3.70	15.19	12.73
25	10	21.00	4.16	20.56	14.10
26	13	22.15	2.19	21.90	13.85
27	10	17.30	4.19	17.29	13.50
28	8	19.63	4.24	18.53	15.00
31	9	21.00	4.69	21.43	12.89
32	12	15.42	3.87	17.15	11.08
33	11	19.36	4.37	17.15	16.55
34	13	18.77	4.09	18.07	14.46
35	11	16.00	3.46	18.13	10.55
36	11	20.09	3.88	18.54	15.64
37	15	16.07	3.22	16.81	12.47
38	13	16.85	5.44	17.42	12.69

An analysis of variance on residual gain scores was performed to confirm the results of the analysis of covariance. The residual gain score used in this analysis was computed using the within-class pooled regression coefficient of experimental classes only. The results of the analysis of variance, indicating a significant difference at the .001 level, are summarized in Table 154.

This is the same result obtained with the analysis of covariance, but is somewhat surprising since no differences were found between classes in Unit I. Table 155 summarizes the means and standard deviations for residual gain scores for each class in the experimental group.

Table 154. Analysis of Variance Between Classes on Residual Gain Scores, Experimental Group, Unit II

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	35.1114	3.0515**
Within Groups	158	11.5061	

**Significance at the .001 level, $F_{.001(15,158)} = 2.51$

Discussion

The significant differences between experimental classes were not entirely unexpected. Teachers deviated from recommended strategies much more in Unit II than in Unit I. Since there is surely a link between teacher performance and student achievement in a program like *ME NOW*, we feel that teacher behavior and comportment are important factors in the significant differences. The importance of classroom observers during experimental trials should be emphasized in future trials of similar materials.

Factorial Analysis, Experimental Group

The results of the multiple linear regression on the posttest indicated that WISC Total IQ, sex and teacher's assessment of reading achievement were significant predictors of success on the posttest To further investigate this result and to minimize the effect of the regression to the posttest mean, the following question was investigated: "Is there a significant difference in residual gain scores between students blocked on two levels of sex, three ranges of WISC Full Scale IQ scores, and three ranges of reading achievement?"

For Unit II, factorial analyses were also performed using WISC Verbal and Numerical IQ scores. Because these data are available for a reduced number of students, these analyses were not performed in the three-dimensional model used in the Unit II analysis. Only the results

Table 155. Residual Gain, Class Data, Experimental Group, Unit II

Class Number	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
21	5	-1.65	5.48	2.45	3.99	-9.40	13.39
22	10	0.81	4.00	1.26	7.43	-6.23	13.66
23	12	-0.74	3.23	0.93	2.26	-5.29	7.55
24	11	-3.01	4.07	1.23	3.32	-8.01	11.33
25	10	2.36	3.48	1.10	5.99	-5.57	11.56
26	13	3.70	3.14	0.87	8.60	-0.46	9.06
27	10	-0.91	2.40	0.76	4.04	-3.57	7.61
28	8	0.33	2.78	0.98	4.15	-2.68	6.83
31	9	3.23	3.21	1.07	7.15	-3.23	10.38
32	12	-1.04	3.40	0.98	5.43	-7.29	12.72
33	11	-1.04	2.46	0.74	2.99	-4.80	7.79
34	13	-0.13	3.23	0.90	4.82	-6.01	10.83
35	11	-0.07	3.81	1.15	6.88	-6.74	13.62
36	11	0.34	2.82	0.85	4.37	-5.74	10.11
37	15	-1.39	2.44	0.63	2.77	-5.57	8.34
38	13	-0.78	4.46	1.24	6.15	-6.50	12.65

of the analysis using WISC Full Scale IQ scores with 172 students are reported here.

Residual gain scores for 172 students with WISC Full Scale IQ data were blocked in two different levels of sex: male and female; on three different levels of WISC IQ scores: 66 and less, 67 to 79, and 80 and above; and on three levels of reading achievement: readiness and first grade, second grade, and combined third, fourth and fifth grades. An analysis of variance was performed on the residual gain scores in this 2x3x3 factorial design. Table 156 summarizes the results of the analysis of variance, indicating no significant differences between reading groups, no significant interaction effects for any level of interaction, and significant differences between levels of sex and WISC Full Scale IQ.

Table 156. ANOVA, Residual Gain Blocked on WISC Full Scale IQ, Sex and Reading Level, Experimental Group, Unit II

Source	d.f.	Hypothesis Mean Square	F	Significance Level
Between Sex Levels	1	75.9648	6.2665	P<.0134
Between IQ Levels	2	91.2407	7.5267	P<.0008
Between Reading Levels	2	23.2840	1.9208	P<.1500
Sex - IQ Interactions	2	8.1854	.6752	P<.5106
Sex - Reading Interaction	2	22.0845	1.8218	P<.1652
IQ - Reading Interaction	3	10.8181	.8924	P<.4466
High Level Interaction	4	16.6317	1.3720	P<.2462

Table 157 summarizes the means and standard deviations for each cell in the analysis. Table 158 summarizes the means for the combined cells which form the units of concern.

Table 157. Cell Means and Standard Deviations for Factorial Analysis, Blocked Data, Unit II

	Factor Levels					
Cell	Sex	WISC IQ	Reading	N	Mean	Standard Deviation
1	Male	≤66	Readiness First Grade	14	-1.58	3.29
2	Male	≤66	Second Grade	4	-2.21	5.13
3	Male	≤66	Fourth, Fifth Sixth Grade	3	1.06	2.92
4	Male	67 - 79	Readiness - First Grade	20	-0.61	3.93
5	Male	67 - 79	Second Grade	29	0.79	4.35
6	Male	67 - 79	Fourth, Fifth Sixth Grade	23	0.63	2.91
7	Male	≥80	Readiness - First Grade	6	4.46	1.84
8	Male	≥80	Second Grade	3	1.89	4.59
9	Male	≥80	Fourth, Fifth Sixth Grade	13	1.73	2.77
10	Female	≤66	Readiness - First Grade	6	-3.99	2.36
11	Female	≤66	Second Grade	6	-0.42	4.50
12	Female	≤66	Fourth, Fifth Sixth Grade	4	-1.92	1.22
13	Female	67 - 79	Readiness - First Grade	11	-2.35	2.68
14	Female	67 - 79	Second Grade	7	1.62	2.56
15	Female	67 - 79	Fourth, Fifth Sixth Grade	16	-0.41	3.12
16	Female	≥80	Readiness - First Grade	0	----	----
17	Female	≥80	Second Grade	4	-0.93	5.35
18	Female	≥80	Fourth, Fifth Sixth Grade	3	1.47	1.95

Table 158. Means for Combined Cells - Factorial Analysis
Experimental Group, Unit II

Factor Level	Mean
Males	0.46
Females	-0.96
WISC I Q $\leq$66	-1.67
WISC I Q 67 - 79	3.82
WISC I Q 80 and above	1.92
Readiness - First Grade Reading	-1.01
Second Grade Reading	0.47
Fourth, Fifth, Sixth Grade Reading	0.49

Discussion

The analyses of variance were computed in the 2x3x3 factorial design with residual gain scores blocked on sex; low, middle and high ranges of WISC Full Scale IQ; and three ranges of reading ability. The results indicate that there are no significant differences between reading levels when the residual gain score is the dependent variable. Reading achievement for Unit II must be treated like age in Unit I -- the multiple linear regression identified both as predictors of success on the posttest instrument, but there are no differences in posttest achievement between the reading levels used in this analysis. A regression to the posttest mean could account for the results of the regression analysis.

There was a significant difference in level of achievement between males and females in Unit II (P<.0134). We can only conclude that males do better than females. Any speculation on why would be only that -- speculation.

Students in Unit II with WISC Full Scale IQ scores between 67 and 79 scored significantly higher than students with IQ scores of 80 and above. Both of these groups scored significantly higher than students whose IQ score was 66 or less (P<.0008). Since *ME NOW* was designed for students with an IQ of 65 to 80, these results indicate that the Unit II materials are suitable for the target population. The *ME NOW* materials are probably too difficult for students with WISC Full Scale IQ scores below 65. Why students with IQ scores of 80 and above did not achieve higher scores is unknown. Many such students in EMH classes are emotionally disturbed and not mentally handicapped. The effect of mental disturbances on achievement in *ME NOW* has not been investigated. Suggestions for teachers should be included in the Teacher's Guide for students with IQ scores below 65.

Experimental-Control Group Analyses

To investigate the question, "Is there a significant difference in student achievement between the experimental and control groups?" residual gain scores were computed using the raw regression coefficient, obtained by pooling all experimental and control students, and an analysis of variance was performed. Table 159 summarizes the mean residual gain scores and standard deviations for both groups.

Table 159. Residual Gain Means and Standard Deviations Experimental and Control Groups, Unit II

Group	N	Mean	Standard Deviation
Experimental	174	1.76	3.68
Control	169	-1.79	3.61

Table 160 summarizes the results of the analysis of variance, indicating a significant difference between experimental and control groups (P<.001).

Table 160. ANOVA, Experimental and Control Residual Gain Scores, Unit II

Source	d.f.	Mean Square	F-Ratio
Between Groups	1	1083.4948	81.5690**
Within Groups	341	13.2832	

**Significant at .001 level, $F_{.001(1,341)} = 10.83$

Discussion

The results of the analysis of variance indicated that there was a significant difference between the experimental and control groups on residual gain scores (P<.001). On the basis of these results, we concluded that the experimental Unit II materials did have an effect on EMH students, as assessed by the objective tests. All 30 items on both forms assessed achievement on major objectives in Unit II, four were judged to measure baseline information, and 27 were considered to be good indicators of student growth from pretest to posttest.

Factor Analysis

To determine the structure of the Unit II achievement tests, a Harris-Kaiser oblique, unnormalized, orthogonal rotation was performed on the results of posttests A and B. For posttest A, 19 factors were identified which accounted for 48.9 percent of the variance. For posttest B, 19 factors were identified which accounted for 51.5 percent of the variance.

Table 161 presents the results for posttest A showing only those factors with eigenvalues above 1. The objective measured and cognitive level of each item is included, as is a hypothetical name for each factor. The cognitive levels identified are the same as for Unit I.

Table 161. Factor Structure - Unit II, Posttest A

Factor	Items	Cognitive Level	Objective	Name
1	9	low	200	diaphragm identification
	22	knowledge	200	
2	5	low	201	exercise - energy release
	14	low	202	relationships
3	24	low	201	respiratory - circulatory
	30	high	200	relationships
4	13	knowledge	200	respiratory - excretory
	29	low	202	relationships
5	3	high	202	oxygen - carbon dioxide
	28	low	201	relationships

Table 162 presents the results for posttest B showing only those factors with eigenvalues above 1.

Although no pairs of factors from the two test forms were identical, seven item pairs appeared in the five factors reported here. Items loading on the five factors with eigenvalues above 1 in each test form were well distributed across the test and measured identical or closely related objectives.

Table 162. Factor Structure - Unit II, Posttest B

Factor	Items	Cognitive Level	Objective	Name
1	9	low	202	respiratory - energy relationships
	15	knowledge	201	
	28	low	202	
2	6	knowledge	202	organ recognition
	18	knowledge	200	
3	25	low	202	circulatory - respiratory relationships
	10	knowledge	203	
4	12	low	201	exercise - breathing rate relationships
5	1	high	200	respiratory - excretory functions
	7	low	200	
	20	low	202	

Summary

We can safely conclude that the EMH students in our sample learned from the experimental Unit II materials. Pretest-to-posttest gains in item scores were generally excellent and item response patterns helped identify and/or confirm problems with the experimental materials. Student enthusiasm was high and teacher feedback indicated that there were many applications and extensions to the activities. Experimental group achievement was superior to that of the control group, in spite of the fact that three control classes were taught the subject matter covered by the tests because of student interest generated during test administration.

CHAPTER IV

EVALUATION OF UNIT III

MOVEMENT, SUPPORT, AND SENSORY PERCEPTION

The Instructional Program

For the experimental classes, instruction with the experimental Unit III materials was initiated in the Spring of 1971. The first class began on February 3 and the last on April 1, 1971. The first class finished Unit III on March 8 and the last class finished on May 5, 1971. The total class time devoted to instruction of Unit III ranged from 450 to 1,290 minutes, with a mean for the 16 classes of 659 minutes (11 hours).

The role of muscle, bones, brain, nerves and sensory receptors in *ME NOW* is the focus of Unit III. Students begin the unit by feeling their biceps relax and contract and then build a paper model of a muscle. The relationship between muscles and bones is developed by attaching the muscle model to yardsticks; the students' conclusions are verified by dissecting a chicken wing and observing the muscles and bones. Muscle conditioning by exercise is investigated, followed by an investigation of the protective functions of bones and muscles.

The concept of balance is introduced by using a ruler and paper clips, after which inquiries are conducted using each of the senses separately. A field trip through the school with blindfolds in place helps students utilize senses other than sight in determining their location within the building. The interaction of senses and student reaction to sensory stimuli is investigated. A review of the role of the senses is conducted by using the film, *Me and My Senses*. The coordinating role of the brain is investigated through the use of a puppet and slides, as is the role of the nerves. The role of the brain in learning is investigated by using slides and a maze, and the different perceptions of objects by different people is investigated by the use of inkblots, slides and worksheets. An attempt to influence student attitude in a positive manner is made in the last activity through the use of the film, *Garbage*, and student-teacher dialogue.

Objective 300. *Students will associate bones and muscles with body movement, support and balance*. Six student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 1 to 3, 75 percent of the teachers reported using the strategies as prescribed; 25 percent reported some modification. Ninety-four percent reported the strategies successful. One teacher reported that her students encountered difficulties in folding the paper to construct the muscle model. Another teacher reported, "After children made the bone-muscle model, which they did much faster and with much more accuracy than I thought they would, we taped a foot on it and it became a leg, next we taped a head on it and it became a neck. This, I think, reinforced the idea of muscle-bone relation."

Another teacher reported, "Since we adults had trouble with this activity I knew my class would not be able to work with the chicken wing. So, we all sat around a table and I worked with the wing while they watched. Twice I passed the wing around so they could see what I was doing."

In contrast to the above statement, another teacher wrote, "The dissecting of the chicken wings was out of sight. All the kids were really motivated and excited. I let each child have his own wing within the grouped situation. This added to the motivation and learning desired. I got two chicken feet from the market and we found the tendons in the 'skin' part -- by pulling tendons, we were able to make the chicken claws 'curl up' and straighten when the tendons were released. This delighted the kids and of course they all got into the act."

Another teacher remarked, "I have regular fourth and sixth graders participate in our science program. My boys have a considerably better understanding of arm structure than either of these groups."

It is evident that where prescribed strategies were followed, student enthusiasm was high and they were able to perform the tasks in the activities. However, as the literature states repeatedly, where a teacher's expectation is very low, student success will also be very low.

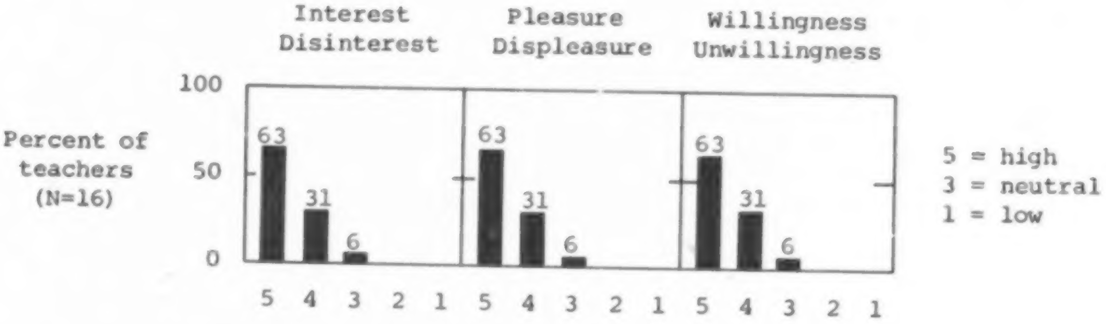


Figure 82. Reaction of the majority of students to activities 1 to 3

Figure 82 shows that teachers found student reactions to be very high across the three rating scales. All activities were judged to be important, but activity 3 was rated more important than 1 or 2. The average rating for the three activities is found in Figure 83.

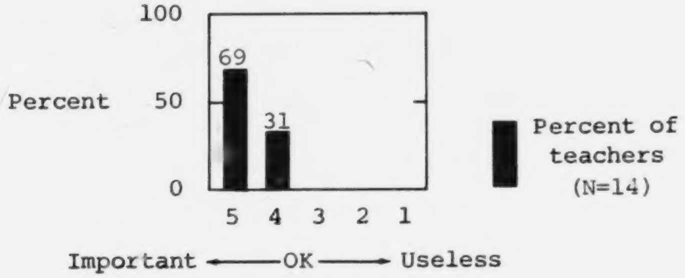


Figure 83. Importance to students of activities 1 to 3

Figure 84 shows the proportion of students who were able to perform the behaviors specified by the seven subobjectives. Eighty-seven percent of the teachers reported that three-fourths or more of their students could perform the prescribed behaviors. Teachers considered the subobjectives for this objective to be important (see Figure 85).

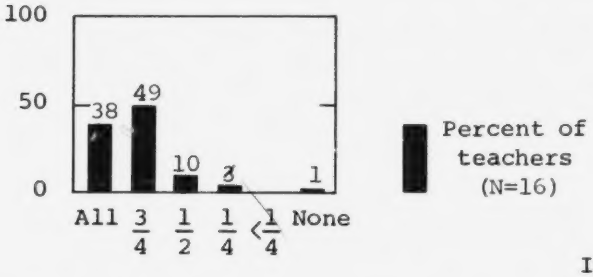


Figure 84. Proportion of students able to perform on subobjectives of objective 300

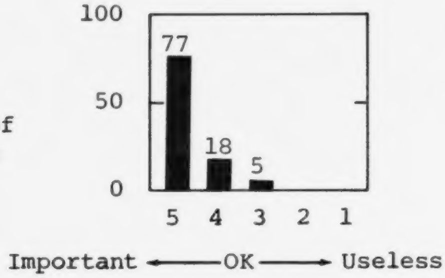


Figure 85. Importance of the subobjectives

For activities 4 to 6, 63 percent of the teachers reported using the strategies as described; 37 percent reported some modification. All teachers reported the strategies successful. One very useful modification was suggested by a teacher: "Instead of giving everyone a box to work with for the balancing, for my group I felt it wiser to present the task as a challenge to individuals. Different people, ultimately everyone, volunteered to demonstrate the fete. The focus of attention was much more intent on the idea and what it meant than if I had asked everyone to do it at the same time."

Figure 86 shows that teachers found student reactions to be high across the three rating scales. Activity 6 was considered to be more important than activity 5, and activity 4 was considered to be least important of the three. The average ratings for the three activities are shown in Figure 87.

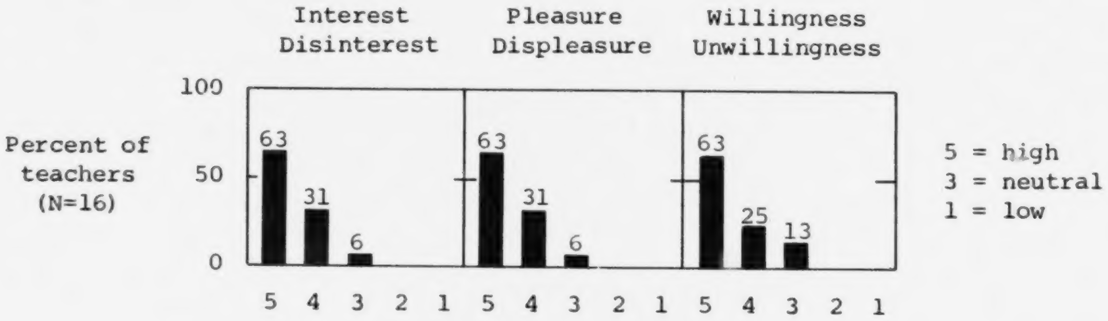


Figure 86. Reaction of the majority of students to activities 4 to 6

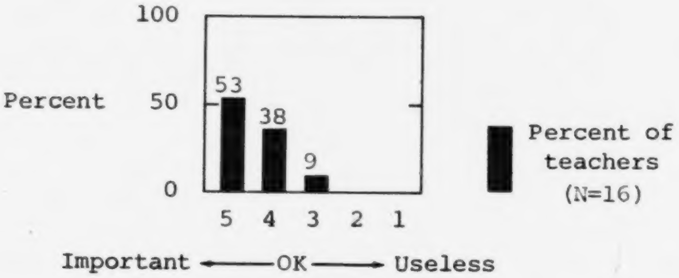


Figure 87. Importance to students of activities 4 to 6

Figure 88 shows the proportion of students who were able to perform the behaviors specified by the seven subobjectives. Sixty-five percent of the teachers reported that three-fourths or more of their students were successful. Teachers considered the subobjectives to be important (see Figure 89).

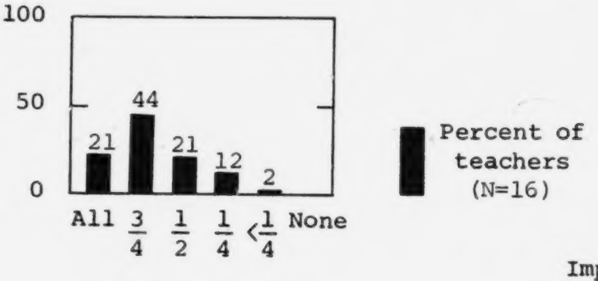


Figure 88. Proportion of students able to perform on subobjectives of objective 300

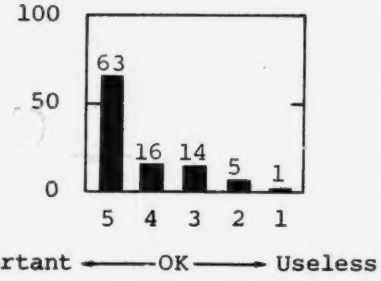
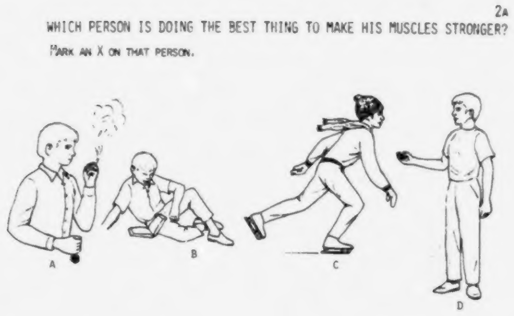
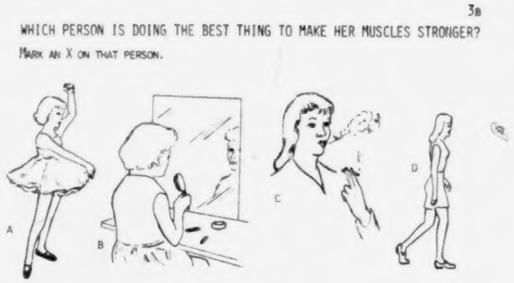


Figure 89. Importance of the subobjectives

Eight item pairs were designed to sample achievement on this objective.



WHICH PERSON IS DOING THE BEST THING TO MAKE HIS MUSCLES STRONGER?
MARK AN X ON THAT PERSON.



WHICH PERSON IS DOING THE BEST THING TO MAKE HER MUSCLES STRONGER?
MARK AN X ON THAT PERSON.

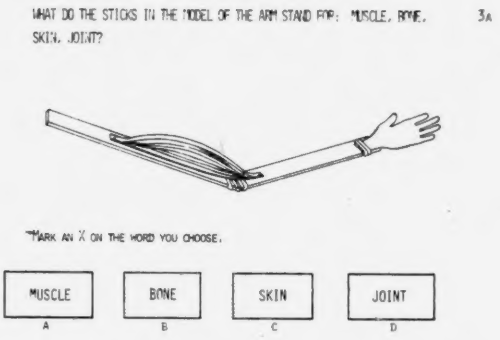
Item pair 2-A, 3-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was nine percent (from 71 to 80 percent). However, the achievement level on Form B was much lower than on Form A. This suggests that students are having difficulty identifying dancing as an exercise more strenuous than walking. Consequently, the dancing girl was replaced by a swimmer. There was a mean net loss of four percent from pretest to posttest for the control group. Therefore, experimental group gains can be attributed to the effect of instruction. Biserial correlation levels indicate that both items are good discriminators.

Table 163. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	2-A	78	0	0	95	5	0	0	85	0	1	94	5	0	0	.55	.40
	3-B	85	47	2	0	51	0	0	78	65	1	1	32	0	0	.23	.36
Control	2-A	84	0	2	94	4	0	0	82	0	2	91	6	0	0	.39	.54
	3-B	82	52	1	6	40	0	0	84	48	4	0	48	0	1	.17	.42

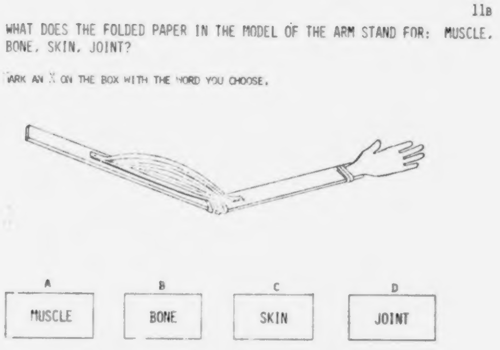
Table 164. Pretest to Posttest Changes (The response choice for 2-A is cited first.)

Item Pair 2-A, 3-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	C	A+C	B	B	B+B	D	D	D+D
Experi-mental	-1	+18	+9	0	+1	0	+1	-1	0	0	-19	-10
Control	-3	-4	-4	0	-6	-3	0	+3	+1	+2	+8	+3



WHAT DO THE STICKS IN THE MODEL OF THE ARM STAND FOR: MUSCLE, BONE, SKIN, JOINT?

MARK AN X ON THE WORD YOU CHOOSE.



WHAT DOES THE FOLDED PAPER IN THE MODEL OF THE ARM STAND FOR: MUSCLE, BONE, SKIN, JOINT?

MARK AN X ON THE BOX WITH THE WORD YOU CHOOSE.

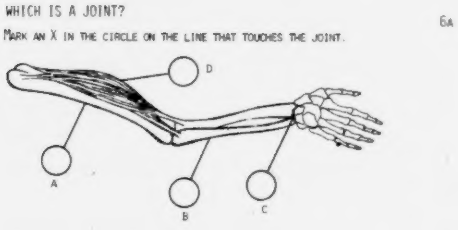
Item pair 3-A, 11-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 16 percent (from 53 to 69 percent). Since achievement on Form B is higher than on Form A, it appears that students are more familiar with muscle than with bone. It was suggested that more emphasis be placed on the role of bones in the revised materials. Mean net gain for the control group was one percent (from 45 to 46 percent). This result enables us to attribute experimental group gains to the effect of instruction. Biserial correlations for the experimental group are very high.

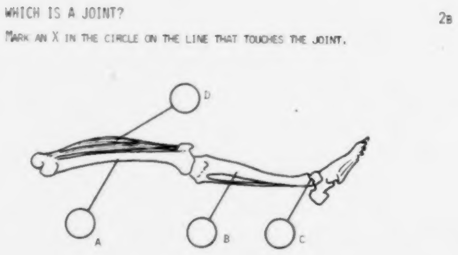
Table 165. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	3-A	78	53	32	6	9	0	0	85	27	51	5	18	0	0	.50	.53
	11-B	85	73	9	4	14	0	0	78	88	1	3	8	0	0	.61	.63
Control	3-A	84	52	24	8	15	0	0	82	55	18	6	18	1	1	.33	-.10
	11-B	82	66	6	6	17	4	1	84	74	7	5	14	0	0	.50	.70

Table 166. Pretest to Posttest Changes (The response choice for 3-A is cited first.)

Item Pair 3-A, 11-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	A	B+A	A	B	A+B	C	C	C+C	D	D	D+D
Experimental	+19	+15	+16	-26	-8	-17	-1	-1	-1	+9	-6	+1
Control	-6	+8	+1	+3	+1	+2	-2	-1	-2	+3	-3	0


WHICH IS A JOINT?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE JOINT.
6A
D
A
B
C


WHICH IS A JOINT?
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THE JOINT.
2B
D
A
B
C

Item pair 6-A, 2-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was 16 percent (from 59 to 75 percent). Mean gain for the control group was

Table 167. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	6-A	78	13	26	50	12	0	0	85	6	9	68	16	0	0	.65	.71
	2-B	85	4	13	68	15	0	0	78	0	6	82	12	0	0	.71	.63
Control	6-A	84	11	17	57	15	0	0	82	11	18	57	12	0	1	.47	.67
	2-B	82	5	17	61	16	0	1	84	6	11	70	13	0	0	.59	.67

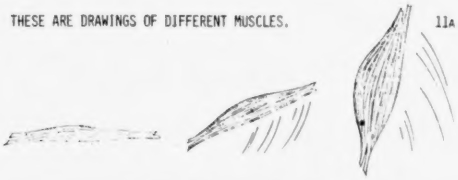
Table 168. Pretest to Posttest Changes (The response choice for 6-A is cited first.)

Item Pair 6-A, 2-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	C	C+C	A	A	A+A	B	B	B+B	D	D	D+D
Experi-mental	+18	+14	+16	-7	-4	-5	-17	-7	-11	+4	-3	0
Control	0	+9	+5	0	+1	0	+1	-6	-3	-3	-3	-2

five percent (from 59 to 64 percent), thus the experimental group gains can be attributed to the effect of instruction. It appears that EMH students in our sample recognized the ankle as a joint with more facility than the wrist; the reason why has not been investigated. Biserial correlations are excellent for both experimental and control groups.

THESE ARE DRAWINGS OF DIFFERENT MUSCLES.

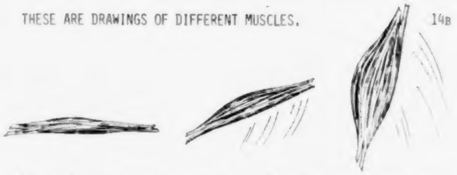
11A



WRITE A 1 ON THE NON-WORKING MUSCLE. WRITE A 2 ON THE BEGINNING TO WORK MUSCLE. WRITE A 3 ON THE HARDEST WORKING MUSCLE.

THESE ARE DRAWINGS OF DIFFERENT MUSCLES.

14B



WRITE A 1 ON THE WORKING MUSCLE. WRITE A 2 ON THE MUSCLE STARTING TO WORK. WRITE A 3 ON THE MUSCLE THAT IS NOT WORKING.

Item pair 11-A, 14-B functions at the cognitive level of analysis and provides baseline information concerning students' knowledge of the manner in which muscles work. Although no gains were achieved by the

Table 169. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	11-A	78	90	3	1	3	0	4	85	92	6	0	0	1	0	.74	.75
	14-B	85	1	90	2	4	2	1	78	1	87	1	1	3	6	.63	.68
Control	11-A	84	93	1	2	1	0	2	82	90	0	1	0	6	2	.60	.22
	14-B	82	3	80	4	2	1	8	84	5	88	0	1	2	4	.72	.64

Table 170. Pretest to Posttest Changes (The response choice for 11-A is cited first.)

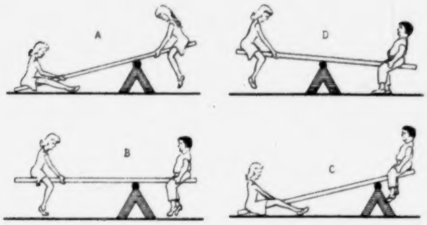
Item Pair 11-A, 14-B	Percent Change Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	B	A+B	B	A	B+A	C	C	C+C	D	D	D+D
Experi-mental	+2	-3	0	+3	0	+2	-1	-1	-2	-3	-3	-4
Control	-3	+8	+2	-1	+2	+1	-1	-4	-3	-1	-1	0

experimental group, an achievement level of 90 percent is entirely satisfactory. The control group gained two percent from pretest to posttest (from 87 to 89 percent). It is evident that the students are already familiar with the concept of muscle contraction, but the *ME NOW* Unit III materials are designed to start at this point and build up a knowledge of the relationships between the muscular system and the other systems of the body. Biserial correlations are exceptionally high for the experimental group and for all but posttest Form A of the control group.

Item pair 13-A, 23-B functions at the cognitive level of comprehension and provides baseline information on students's knowledge of a concept of balance. Mean total gain from pretest to posttest for the

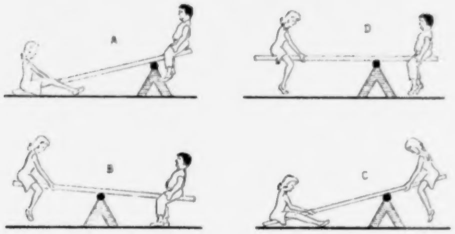
WHICH PICTURE SHOWS BALANCE?
MARK AN X ON THAT PICTURE.

13A



WHICH PICTURE SHOWS BALANCE?
MARK AN X ON THAT PICTURE.

23B



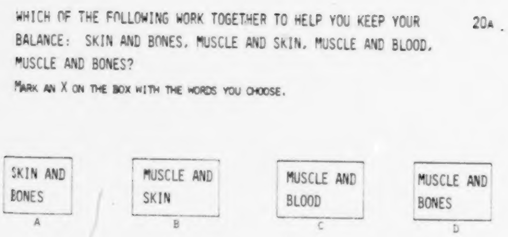
experimental group was seven percent (from 78 to 85 percent). Mean total gain for the control group was ten percent (from 78 to 88 percent). Because of the control group gains, no effect can be attributed to instruction, but the gains can be accounted for by losses on all other response choices. Biserial correlations indicate that the items discriminated well between high- and low-scoring students, except in the case of posttest Form B in the experimental group.

Table 171. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	13-A	78	4	78	13	4	1	0	85	2	87	7	4	0	0	.31	.59
	23-B	85	5	13	78	4	1	0	78	1	12	83	3	1	0	.28	.09
Control	13-A	84	4	81	14	1	0	0	82	0	90	9	0	0	1	.34	.34
	23-B	82	6	13	74	5	0	1	84	2	12	86	0	0	0	.33	.42

Table 172. Pretest to Posttest Changes (The response choice for 13-A is cited first.)

Item Pair 13-A, 23-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	D	A	D+A	C	B	C+B
Experimental	+9	+5	+7	-2	-1	-2	0	-4	-2	-6	-1	-4
Control	+9	+12	+10	-4	-5	-4	-1	-4	-2	-5	-1	-3

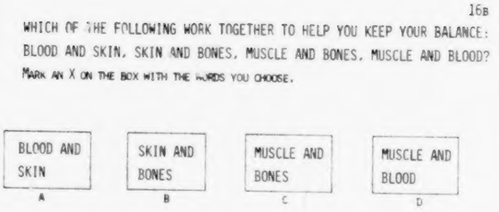


WHICH OF THE FOLLOWING WORK TOGETHER TO HELP YOU KEEP YOUR BALANCE: SKIN AND BONES, MUSCLE AND SKIN, MUSCLE AND BLOOD, MUSCLE AND BONES?

MARK AN X ON THE BOX WITH THE WORDS YOU CHOOSE.

20A .

SKIN AND BONES	MUSCLE AND SKIN	MUSCLE AND BLOOD	MUSCLE AND BONES
A	B	C	D



16B

WHICH OF THE FOLLOWING WORK TOGETHER TO HELP YOU KEEP YOUR BALANCE: BLOOD AND SKIN, SKIN AND BONES, MUSCLE AND BONES, MUSCLE AND BLOOD?

MARK AN X ON THE BOX WITH THE WORDS YOU CHOOSE.

BLOOD AND SKIN	SKIN AND BONES	MUSCLE AND BONES	MUSCLE AND BLOOD
A	B	C	D

Item pair 20-A, 16-B functions at the cognitive level of analysis. Mean total gain from pretest to posttest for the experimental group was 16 percent (from 51 to 67 percent). With the exception of the response choice "skin and bones" all other distractors dropped from pretest to posttest. Mean total gain for the control group was ten percent (from 50 to 60 percent). Based on these results, we can attribute experimental group gains to the effect of instruction. The revised materials should

Table 173. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	0	Pre	Post
Experi-mental	20-A	78	9	12	32	47	0	0	85	13	6	19	61	0	1	.48	.52
	16-B	85	5	9	54	29	1	1	78	4	12	73	12	0	0	.63	.49
Control	20-A	84	8	15	24	52	0	0	82	5	13	21	60	0	1	.46	.46
	16-B	82	5	20	48	24	1	2	84	7	10	60	24	0	0	.42	.58

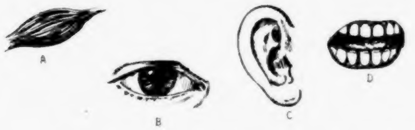
Table 174. Pretest to Posttest Changes (The response choice for 20-A is cited first.)

Item Pair 20-A, 16-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	C	D+C	A	B	A+B	B	A	B+A	C	D	C+D
Experi-mental	+14	+19	+16	+4	+3	+4	-6	-1	-3	-13	-11	-14
Control	+8	+12	+10	-3	-10	-6	-2	+2	0	-3	0	-1

emphasize the difference between skin and muscle to avoid this problem. Biserial correlations are excellent for both experimental and control groups.

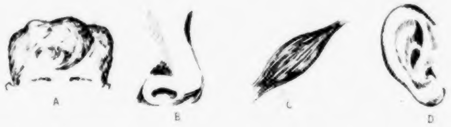
22A

WHICH OF THE FOLLOWING IS THE BEST PROTECTOR FOR BONES AND JOINTS?
MARK AN X ON THE PICTURE YOU CHOOSE.



19B

WHICH OF THE FOLLOWING IS THE BEST PROTECTOR FOR BONES AND JOINTS?
MARK AN X ON THE PICTURE YOU CHOOSE.



Item pair 22-A, 19-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was three percent. Mean total gain for the control group was 11 percent (from 69 to 80 percent), thus we cannot attribute experimental group gains to the effect of instruction. Although the protective

Table 175. Item Responses and Biserial Correlations for Experimental and Control Groups

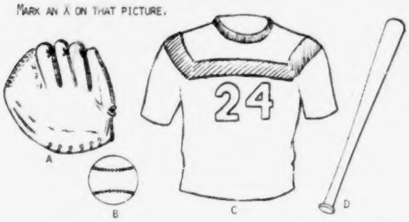
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	22-A	78	79	5	4	12	0	0	85	80	7	7	6	0	0	.38	.63
	19-B	85	19	8	68	4	1	0	78	24	4	71	1	0	0	.40	.63
Control	22-A	84	70	10	6	12	2	0	82	74	4	7	13	0	1	.56	.60
	19-B	82	11	10	68	9	1	1	84	4	4	86	6	1	0	.52	.68

Table 176. Pretest to Posttest Changes (The response choice for 22-A is cited first.)

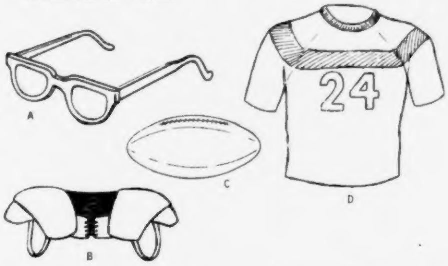
Item Pair 22-A, 19-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	B	B+B	C	D	C+D	D	A	D+A
Experimental	+1	+3	+3	+2	-4	-1	+3	-3	0	-6	+5	-1
Control	+4	+18	+11	-6	-6	-6	+1	-3	-1	+1	-7	-4

function of bones is stressed in Unit III, the protective function of muscles could receive more emphasis. A 76 percent posttest achievement level is satisfactory, however. Biserial correlations are high for both experimental and control groups.

WHICH ACTS MOST LIKE THE BONES OF YOUR HEAD? 24A
MARK AN X ON THAT PICTURE.



WHICH ACTS MOST LIKE THE BONES OF YOUR HEAD? 22B
MARK AN X ON THAT PICTURE.



Item pair 24-A, 22-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was eight percent (from 37 to 45 percent). Mean total gain for the control group was four percent (from 36 to 40 percent), enabling us to attribute experimental group gains to the effect of instruction. It is evident from both the experimental and control group results that EMH students in our sample probably do not think of a baseball mitt as a protective device for the hand, but rather something to facilitate catching the baseball. The 11 percent gain from 53 to 64 percent on Form B where the shoulder pads are the correct choice is satisfactory. Biserial correlations were satisfactory for both groups.

Table 177. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	24-A	78	21	35	5	40	0	0	85	26	27	5	42	0	0	.20	.54
	22-B	85	14	53	32	1	0	0	78	4	64	28	1	3	0	.47	.46
Control	24-A	84	31	24	14	29	2	0	82	27	29	6	35	0	2	.70	.43
	22-B	82	21	41	32	4	1	1	84	11	52	26	11	0	0	.35	.63

Table 178. Pretest to Posttest Changes
(The response choice for 24-A is cited first.)

Item Pair 24-A, 22-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	B	A+B	B	C	B+C	C	D	C+D	D	A	D+A
Experimental	+5	+11	+8	-8	-4	-6	0	0	0	+2	-10	-4
Control	-4	+11	+4	+5	-6	-1	-8	+7	0	+6	-10	-2

Objective 301. Students will associate senses with conscious and unconscious control of body activity. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activity 7, 75 percent of the teachers reported using the strategies as described; 25 percent reported some modification. Ninety-four percent reported that the strategies were successful. Teachers' written comments for activity 7 consisted mainly of mentioning additional items they added to the materials for the students to sample. Most agreed that the students were highly motivated. One pleasing response was, "This activity was too stimulative -- perhaps one 'sense' a day with more activities for each sense. One or perhaps the most exciting results of this program -- for me -- is the increased language development of 2401. He has the most primitive speech pattern of any child I have had -- just never responds -- and gee whiz -- lately he has begun to talk, give ideas -- many of which aren't bad -- and this increased talking is carrying over into other parts of the school day. Thank you for Joe."

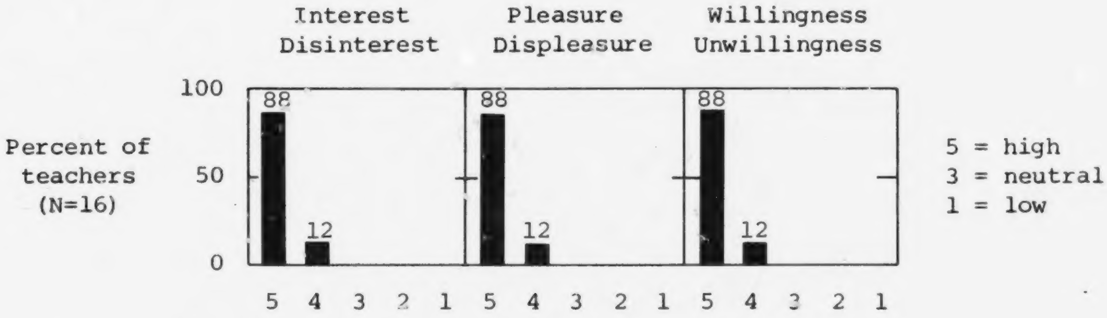


Figure 90. Reaction of the majority of students to activity 7

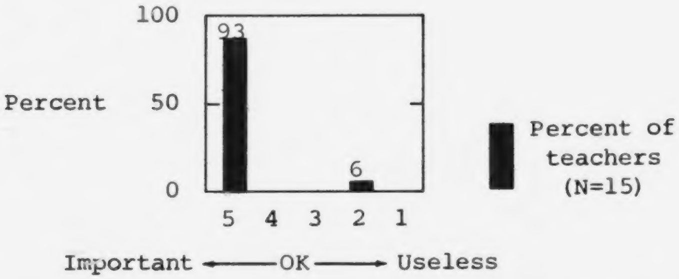


Figure 91. Importance to students of activity 7

Figure 90 shows that student reactions are exceptionally high across the three rating scales. One thing is becoming increasingly clear -- EMH students enjoy doing activities themselves much more than watching demonstrations. Figure 91 shows that the vast majority of the teachers rated activity 7 as being very important. It is interesting to note that the teacher who rated the activity as "2" is the same teacher who did not follow the instructional strategies.

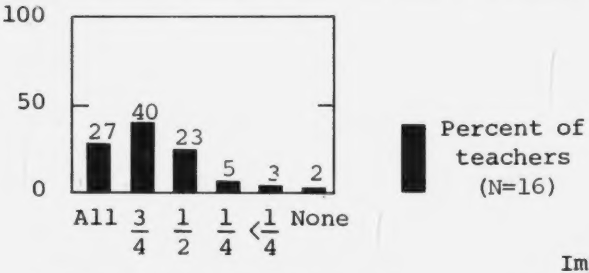


Figure 92. Proportion of students able to perform on subobjectives of objective 301

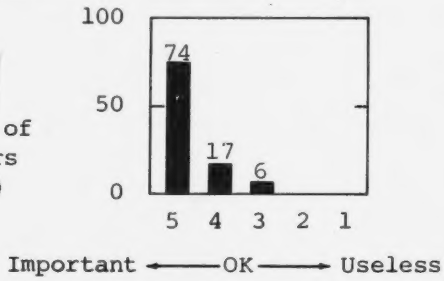


Figure 93. Importance of the subobjectives

Figure 92 shows that the proportion of students able to perform the behaviors specified in the seven subobjectives was relatively high, considering the fact that they were trying to identify objects in boxes, bottles, etc., without the use of sight. Ninety percent reported that one-half or more of their students identified all of the unknowns. Figure 93 shows that most teachers rated the seven subobjectives to be very important.

For activities 8 and 9, 69 percent of the teachers reported using the strategies as described; 31 percent reported some modification. All teachers reported that the strategies were successful. Several minor problems were encountered in these activities. Some of the older students were very self-conscious about going through the school blindfolded, but the younger students thought it was a great experience. Several teachers set up artificial situations in classrooms instead of touring through the building. Another minor problem was encountered when teachers left the vials of butyric acid uncapped for long periods of time and the smell permeated entire school buildings. Ammonia was suggested as a substitute for sensitive noses. The reaction to the film, Me and My Senses, was excellent.

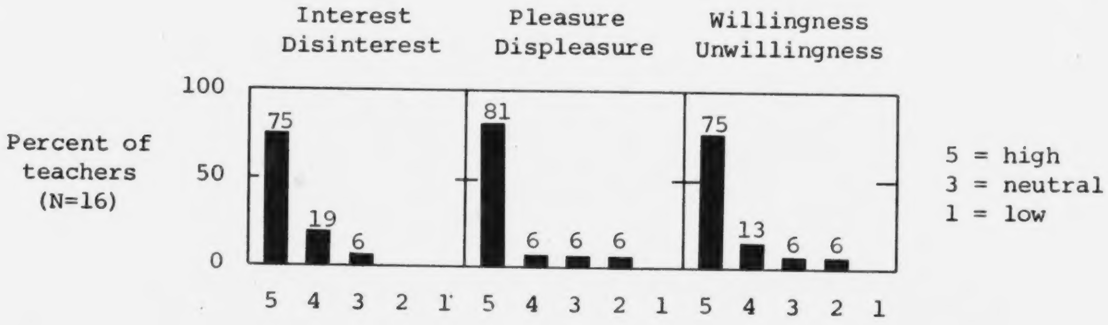


Figure 94. Reaction of the majority of students to activities 8 and 9

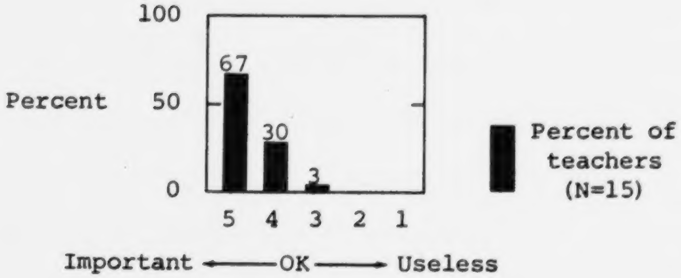


Figure 95. Importance to students of activities 8 and 9

Figure 94 shows that student reactions were again very high across the three rating scales. Most low ratings occurred because of objectional smells, such as butyric acid. Figure 95 shows that teachers rated the activities important for EMH children.

Figure 96 shows that the success rate on performing specified subobjectives was high. Eighty-six percent of the teachers reported that three-fourths or more of their students were able to perform the specified behaviors; 96 percent reported that one-half or more were successful. Figure 97 shows that teachers reported that the subobjectives are important.

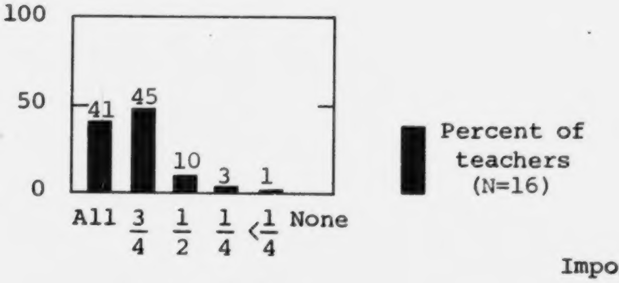


Figure 96. Proportion of students able to perform on subobjectives of objective 301

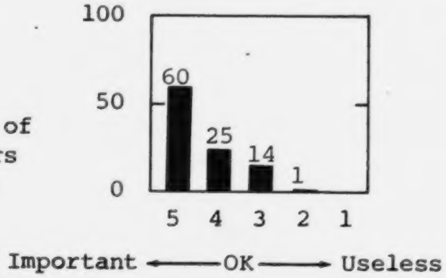
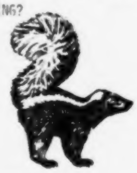


Figure 97. Importance of the subobjectives

Four item pairs were designed to sample achievement on this objective.

1A

WHAT IS THE EASIEST WAY TO TELL WHAT THIS ANIMAL IS: SMELLING, TASTING, TOUCHING, HEARING?

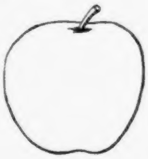


MARK AN X ON THE WORD YOU CHOOSE.

SMELLING	TASTING	TOUCHING	HEARING
A	B	C	D

24B

WHAT IS THE EASIEST WAY TO TELL WHAT COLOR THIS APPLE IS: TOUCHING, SEEING, SMELLING, TASTING?



MARK AN X ON THE WORD YOU CHOOSE.

A	B	C	D
TOUCHING	SEEING	SMELLING	TASTING

Item pair 1-A, 24-B functions at the cognitive level of knowledge and was judged to provide baseline information. Mean net gain from pretest to posttest for the experimental group was two percent (from 88 to 90 percent). There was no gain from pretest to posttest for the control group. Although the gain for the experimental group is low, this is to be expected where pretest achievement levels are high. It

Table 179. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	1-A	78	90	3	6	1	0	0	85	94	1	5	0	0	0	.61	.68
	24-B	85	1	87	1	11	0	0	78	1	86	3	9	1	0	.50	.47
Control	1-A	84	90	2	5	2	0	0	82	87	1	9	2	1	0	.55	.49
	24-B	82	2	76	7	11	1	2	84	1	80	4	15	0	0	.76	.54

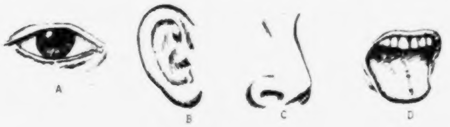
Table 180. Pretest to Posttest Changes
(The response choice for 1-A is cited first.)

Item Pair 1-A, 24-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	B	A+B	B	D	B+D	C	A	C+A	D	C	D+C
Experimental	+4	-1	+2	-2	-2	-2	-1	0	0	-1	+2	0
Control	-3	+4	0	-1	+4	+2	+4	-1	+1	0	-3	-1

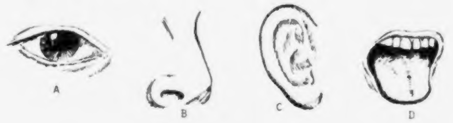
is evident that students recognize single senses which are involved in identifying different objects. Biserial correlations were excellent for both the experimental and control groups.

7A

WHEN YOU USED THE STARCH TEST SOLUTION WHICH OF THE FOLLOWING HELPED YOU TELL IF STARCH WAS PRESENT?
MARK AN X ON THAT PICTURE.



WHEN YOU USED THE SUGAR TEST SOLUTION WHICH OF THE FOLLOWING HELPED YOU TELL IF SUGAR WAS PRESENT? 12B
MARK AN X ON THAT PICTURE.



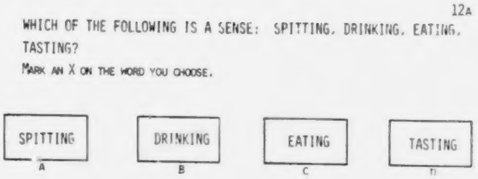
Item pair 7-A, 12-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was three percent (from 54 to 57 percent). Mean net gain for the control group was also three percent, but the response patterns were more random and weighted toward the use of taste as an identifying sense. This was a difficult item pair because it involved the recall of starch and sugar testing from Unit I and the association of a sense with the results of the Unit I activity. In view of this difficulty, 57 percent is considered to be an excellent level of achievement. Biserial correlations for the experimental group were excellent and indicate strongly that there was an effect due to instruction on this item pair.

Table 181. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	7-A	78	55	3	5	37	0	0	85	60	2	7	31	0	0	.54	.67
	12-B	85	53	12	4	31	1	0	78	53	0	1	45	1	0	.67	.64
Control	7-A	84	40	12	19	27	1	0	82	35	2	18	43	0	1	.63	.04
	12-B	82	13	4	7	74	1	0	84	26	4	1	68	1	0	.40	.65

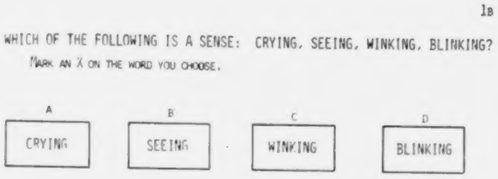
Table 182. Pretest to Posttest Changes
(The response choice for 7-A is cited first.)

Item Pair 7-A, 12-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	C	B+C	C	B	C+B	D	D	D+D
Experimental	+5	0	+3	-1	-3	-2	+2	-12	-5	-6	+14	+4
Control	-5	+13	+3	-10	-6	-9	-1	0	-1	+16	-6	+6


12A

WHICH OF THE FOLLOWING IS A SENSE: SPITTING, DRINKING, EATING, TASTING?
MARK AN X ON THE WORD YOU CHOOSE.

SPITTING
A
DRINKING
B
EATING
C
TASTING
D


1B

WHICH OF THE FOLLOWING IS A SENSE: CRYING, SEEING, WINKING, BLINKING?
MARK AN X ON THE WORD YOU CHOOSE.

A
CRYING
B
SEEING
C
WINKING
D
BLINKING

Item pair 12-A, 1-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 34 percent (from 47 to 81 percent). Mean net gain for the control group was three percent (from 50 to 53 percent). These results clearly indicate that the experimental group gains can be attributed to the effect of instruction. The gains can be accounted for by losses on all other response choices, except for a gain of three percent on drinking in Form A. Biserial correlations approach the phenomenal level for both

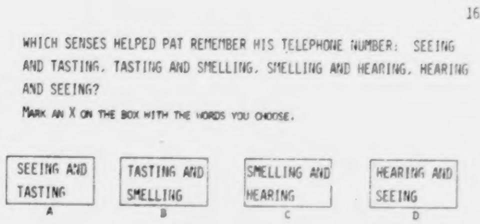
Table 183. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	12-A	78	13	8	31	49	0	0	85	4	11	11	75	0	0	.67	.71
	1-B	85	26	46	6	21	1	0	78	4	88	5	2	0	0	.23	.89
Control	12-A	84	15	10	20	55	0	0	82	13	30	9	46	0	1	.58	.68
	1-B	82	15	45	20	21	0	0	84	17	60	8	15	0	0	.41	.56

Table 184. Pretest to Posttest Changes
(The response choice for 12-A is cited first.)

Item Pair 12-A, 1-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	A	A+A	B	C	B+C	C	D	C+D
Experimental	+26	+42	+34	-9	-22	-16	+3	-1	+1	-20	-19	-19
Control	-9	+15	+3	-2	+2	0	+20	-12	+4	-11	-6	-8

items in the experimental and control groups. The enthusiasm generated during activities involving the senses seems to have had an effect on learning.

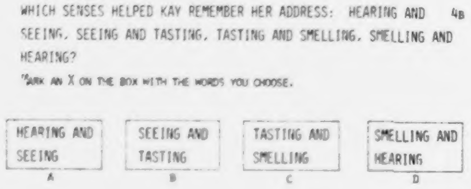


16A

WHICH SENSES HELPED PAT REMEMBER HIS TELEPHONE NUMBER: SEEING AND TASTING, TASTING AND SMELLING, SMELLING AND HEARING, HEARING AND SEEING?

MARK AN X ON THE BOX WITH THE WORDS YOU CHOOSE.

SEEING AND TASTING	TASTING AND SMELLING	SMELLING AND HEARING	HEARING AND SEEING
A	B	C	D



4B

WHICH SENSES HELPED KAY REMEMBER HER ADDRESS: HEARING AND SEEING, SEEING AND TASTING, TASTING AND SMELLING, SMELLING AND HEARING?

MARK AN X ON THE BOX WITH THE WORDS YOU CHOOSE.

HEARING AND SEEING	SEEING AND TASTING	TASTING AND SMELLING	SMELLING AND HEARING
A	B	C	D

Item pair 16-A, 4-B functions as the cognitive level of knowledge and provides baseline information concerning the use of senses in remembering. Mean total gain from pretest to posttest for the experimental group was six percent (from 83 to 89 percent). Mean net gain for the control group was four percent (from 73 to 77 percent).

Table 185. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	16-A	78	3	3	8	87	0	0	85	1	2	7	88	0	1	.59	.79
	4-B	85	79	6	2	13	0	0	78	90	5	3	3	0	0	.54	.64
Control	16-A	84	8	4	5	83	0	0	82	6	5	10	78	0	1	.21	.56
	4-B	82	63	15	7	13	0	1	84	77	10	4	10	0	0	.67	.77

Table 186. Pretest to Posttest Changes
(The response choice for 16-A is cited first.)

Item Pair 16-A, 4-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	B	A+B	B	C	B+C	C	D	C+D
Experimental	+1	+11	+6	-2	-1	-2	-1	+1	0	-1	-10	-6
Control	-5	+14	+4	-2	-5	-3	+1	-3	-1	+5	-3	+1

Although gains were registered by both groups, we attribute experimental group gains to the effect of instruction. Biserial correlations are excellent for both groups.

Objective 302. Students will associate the brain with control of body activity. Three activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 10 and 11, 69 percent of the teachers reported that they used the strategies as described; 31 percent reported some modification. Ninety-four percent of the teachers reported that the strategies were successful and six percent reported that they were unsuccessful. Some minor problems were encountered in cutting out and assembling the puppets, but improved art and instructions should correct this in the

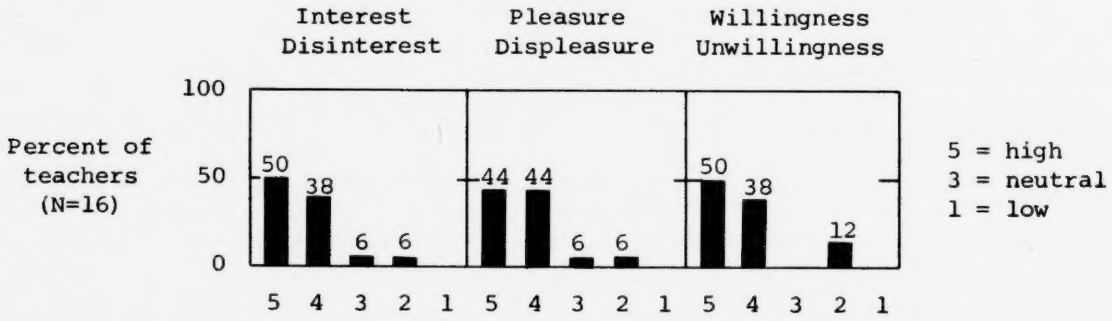


Figure 98. Reaction of the majority of students
to activities 10 and 11

revised materials. In lesson 11 one teacher wrote, "We got into a discussion of voluntary and involuntary movement that was worthwhile. The kids greatly enjoyed relating their personal experiences and identifying their own body functions with the subjects under discussion."

Figure 98 shows that student reactions were high across the three rating scales, but not as high as on previous activities. Figure 99 shows that teachers considered the activities to be important.

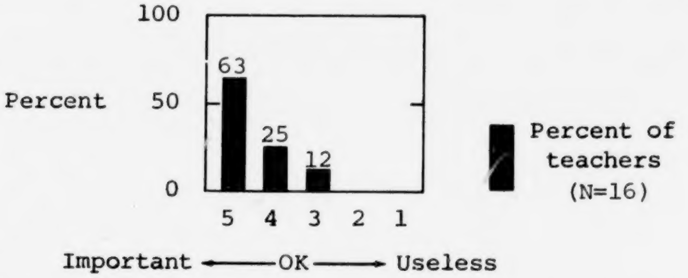


Figure 99. Importance to students of activities 10 and 11

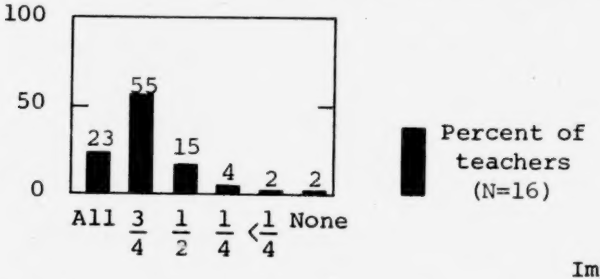


Figure 100. Proportion of students able to perform on subobjectives of objective 302

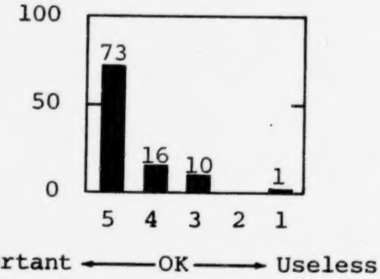


Figure 101. Importance of the subobjectives

Figure 100 shows the average across the seven subobjectives of the proportion of students who were able to perform the desired behaviors. Seventy-eight percent of the teachers reported that three-fourths or more of their students could perform the desired behaviors; 93 percent reported that one-half or more of their students were successful. These levels should increase with the use of the functioning torso in the revised materials. Figure 101 shows that teachers considered the subobjectives to be important.

For activity 12, 81 percent of the teachers reported using the strategies as described; 13 percent reported some modification; and six percent reported much modification. Ninety-four percent reported that the strategies were successful and six percent reported that they were unsuccessful. Some teachers reported that students would not trust them after eating the bittersweet chocolate. One suggested that a square of sweet chocolate should be offered after the deception of the bittersweet chocolate.

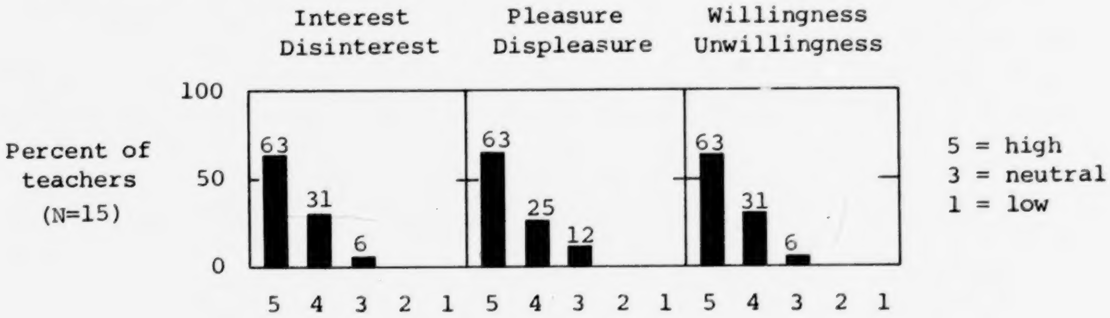


Figure 102. Reaction of the majority of students to activity 12

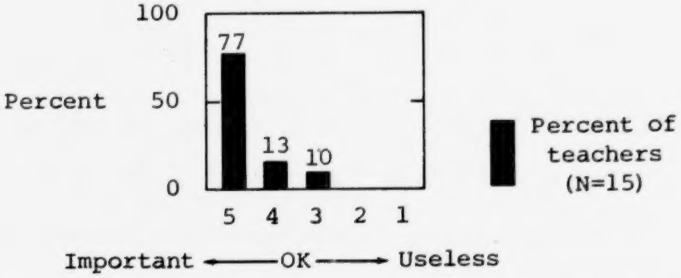


Figure 103. Importance to students of activity 12

Figure 102 shows that student reactions to activity 12 were high across the three rating scales. Figure 103 shows that teachers considered activity 12 to be important.

Figure 104 shows that 77 percent of the teachers reported that three-fourths or more of their students could perform the desired behaviors specified in the subobjectives. Ninety-seven percent reported that one-half or more of their students were successful. Figure 105 shows that teachers considered the subobjectives to be important.

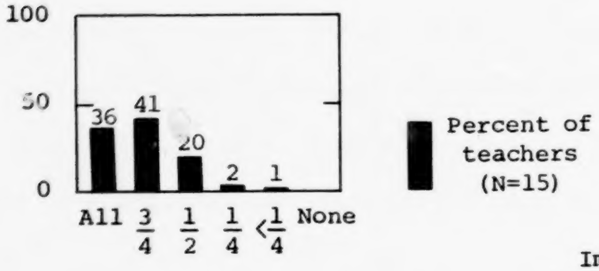


Figure 104. Proportion of students able to perform on subobjectives of objective 302

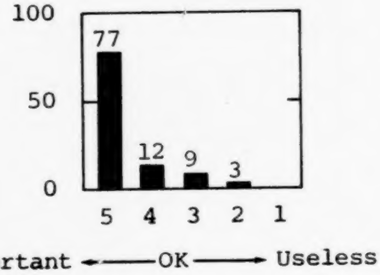
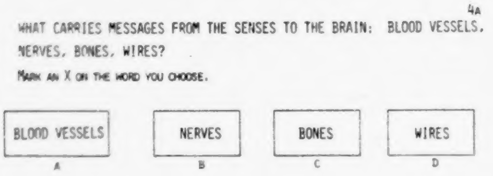


Figure 105. Importance of the subobjectives

Eight item pairs were designed to assess student achievement on objective 302.

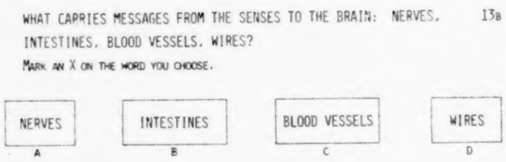


4A

WHAT CARRIES MESSAGES FROM THE SENSES TO THE BRAIN: BLOOD VESSELS, NERVES, BONES, WIRES?

MARK AN X ON THE WORD YOU CHOOSE.

BLOOD VESSELS A | NERVES B | BONES C | WIRES D



13B

WHAT CARRIES MESSAGES FROM THE SENSES TO THE BRAIN: NERVES, INTESTINES, BLOOD VESSELS, WIRES?

MARK AN X ON THE WORD YOU CHOOSE.

NERVES A | INTESTINES B | BLOOD VESSELS C | WIRES D

Item pair 4-A, 13-B functions at the cognitive level of knowledge. Mean total gain from pretest to posttest for the experimental group was 33 percent (from 46 to 79 percent). Mean total gain for the control group was seven percent (from 54 to 61 percent). Experimental group gains are attributed to the effect of instruction and can be accounted for by losses in all other response choices. The achievement level on this item was excellent. Biserial correlations are excellent for both groups.

Table 187. Item Responses and Biserial Correlations for Experimental and Control Groups

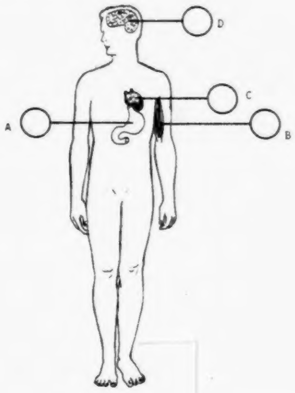
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	4-A	78	41	41	6	12	0	0	85	9	85	1	4	1	0	.49	.76
	13-B	85	51	5	35	8	1	0	78	73	1	17	8	1	0	.51	.65
Control	4-A	84	13	67	12	8	0	0	82	29	54	5	11	0	1	.46	.42
	13-B	82	40	18	26	16	0	0	84	67	10	11	12	1	0	.63	.63

Table 188. Pretest to Posttest Changes (The response choice for 4-A is cited first.)

Item Pair 4-A, 13-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	A	B+A	A	C	A+C	C	C	C+C	D	D	D+D
Experi-mental	+44	+22	+33	-32	-18	-25	-5	-18	-12	-8	0	-4
Control	-13	+27	+7	+16	-15	+1	-7	-15	-11	+3	-4	0

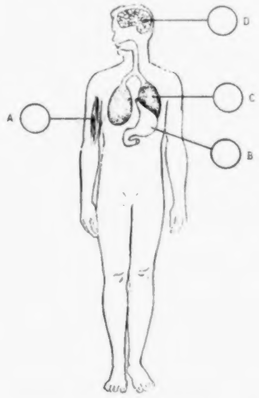
WHAT PART OF THE BODY DIRECTS PHYSICAL ACTIVITY? 8A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHAT PART OF THE BODY CONTROLS PHYSICAL ACTIVITY? 9B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



Item pair 8-A, 9-B functions at the cognitive level of comprehension. Mean total gain from pretest to posttest for the experimental group was five percent (from 57 to 62 percent). Mean total gain for the

Table 189. Item Responses and Biserial Correlations for Experimental and Control Groups

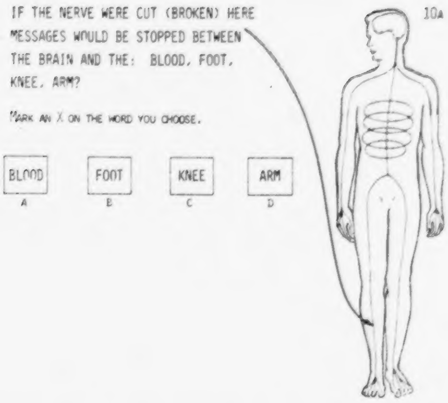
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	8-A	78	8	21	17	55	0	0	85	6	16	20	58	0	0	.59	.45
	9-B	85	14	16	12	58	0	0	78	15	9	9	67	0	0	.56	.69
Control	8-A	84	6	19	18	56	0	1	82	17	15	16	51	0	1	.66	.41
	9-B	82	20	20	18	38	2	2	84	14	15	13	57	0	0	.62	.72

Table 190. Pretest to Posttest Changes
(The response choice for 8-A is cited first.)

Item Pair 8-A, 9-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	B	A+B	B	A	B+A	C	C	C+C
Experimental	+3	+9	+5	-2	-7	-5	-5	+1	-1	+3	-3	+1
Control	-5	+19	+7	+11	-5	+3	-4	-6	-5	-2	-5	-4

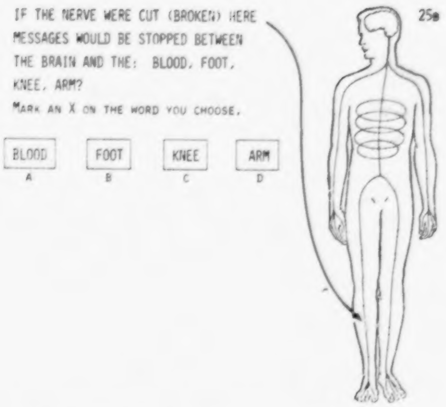
control group was seven percent (from 47 to 54 percent). Because of the control group gains, the gains of the experimental group cannot be attributed to the effect of instruction. Teacher comments and interviews with students indicate that the words "directs physical activity" are not understood by the students. The revised tests were subsequently changed to "which part of the body controls your muscles." Both pretest and posttest biserial correlations were very high.

Item pair 10-A, 25-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was five percent (from 41 to 46 percent). There was a mean net loss of one percent (from 37 to 36 percent) for the control group, enabling us to attribute the experimental group gains to the effect of instruction. This



IF THE NERVE WERE CUT (BROKEN) HERE MESSAGES WOULD BE STOPPED BETWEEN THE BRAIN AND THE: BLOOD, FOOT, KNEE, ARM?

MARK AN X ON THE WORD YOU CHOOSE.



IF THE NERVE WERE CUT (BROKEN) HERE MESSAGES WOULD BE STOPPED BETWEEN THE BRAIN AND THE: BLOOD, FOOT, KNEE, ARM?

MARK AN X ON THE WORD YOU CHOOSE.

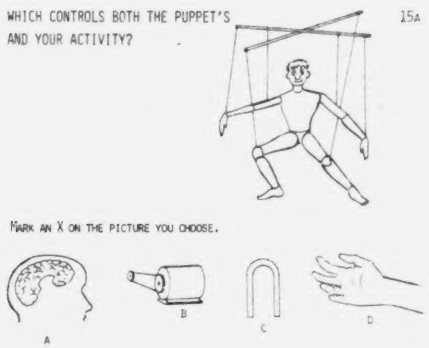
conclusion is also verified by the shift in biserial correlations from pretest to posttest for the experimental group. Students with visual reception problems probably encountered difficulties with this item pair because of the nature of the visual task of tracing the nerve from the arrow point back to the brain. This stylized human figure was dropped from the revised test because student achievement was much better on a more realistic figure (see item pair A-25, B-7).

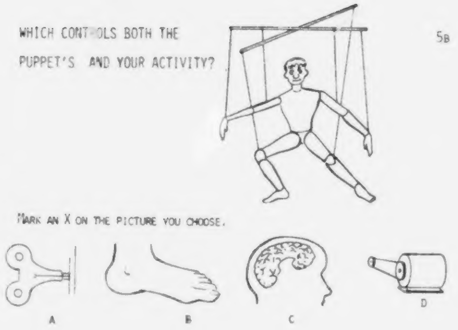
Table 191. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	10-A	78	19	37	36	6	1	0	85	15	42	39	2	1	0	.33	.32
	25-B	85	19	44	27	5	6	0	78	13	50	26	9	3	0	.43	.66
Control	10-A	84	17	45	23	13	2	0	82	26	22	40	9	4	0	.20	.18
	25-B	82	12	29	32	22	5	0	84	8	49	32	8	2	0	.51	.57

Table 192. Pretest and Posttest Changes
(The response choice for 10-A is cited first.)

Item Pair 10-A, 25-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	C	C+C	D	D	D+D
Experimental	+5	+6	+5	-4	-6	-5	+3	-1	+2	-4	+4	0
Control	-23	+20	-1	+9	-4	+2	+17	0	+9	-4	-14	-9


WHICH CONTROLS BOTH THE PUPPET'S AND YOUR ACTIVITY?
15A
MARK AN X ON THE PICTURE YOU CHOOSE.
A
B
C
D


WHICH CONTROLS BOTH THE PUPPET'S AND YOUR ACTIVITY?
5B
MARK AN X ON THE PICTURE YOU CHOOSE.
A
B
C
D

Item pair 15-A, 5-B functions at the cognitive level of analysis. Mean total gain from pretest to posttest for the experimental group was 25 percent (from 50 to 75 percent). Mean total gain for the control group was 19 percent (from 40 to 59 percent). We attribute the experimental group gains to the effect of instruction and they can be accounted for by losses on all other response choices. This item shows very good growth in terms of knowledge of the function of the brain.

Table 193. Item Responses and Biserial Correlations for Experimental and Control Groups

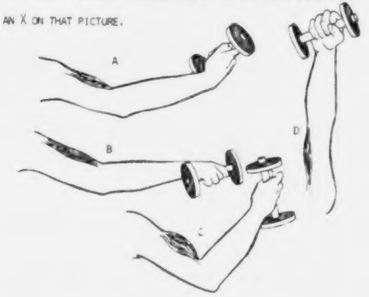
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	15-A	78	33	4	3	55	5	0	85	66	4	1	26	2	1	.41	.45
	5-B	85	15	9	64	8	2	1	78	5	5	85	0	5	0	.37	.82
Control	15-A	84	32	14	7	43	4	0	82	41	10	1	37	10	1	.48	.64
	5-B	82	27	17	48	4	4	1	84	8	6	75	7	4	0	.68	.73

Table 194. Pretest to Posttest Changes
(The response choice for 15-A is cited first.)

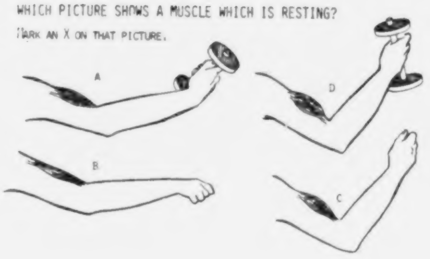
Item Pair 15-A, 5-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	D	B+D	C	A	C+A	D	B	D+B
Experimental	+33	+21	+25	0	-8	-4	-2	-10	-6	-29	-4	-15
Control	+9	+27	+19	-4	+3	-1	-6	-19	-12	-6	-11	-9

Biserial correlations are very high for both forms of the test and for both the pretest and the posttest.

WHICH PICTURE SHOWS A MUSCLE WHICH IS LIFTING SOMETHING? 17A
MARK AN X ON THAT PICTURE.



WHICH PICTURE SHOWS A MUSCLE WHICH IS RESTING? 17B
MARK AN X ON THAT PICTURE.



Item pair 17-A, 17-B functions at the cognitive level of comprehension and was judged to provide baseline information. There was a mean net loss from pretest to posttest for the experimental group of five percent (from 79 to 74 percent). There was a loss of two percent (from 78 to 76 percent) for the control group. The BSCS staff recommended that this item be replaced because of inherent problems in the illustrations used.

Table 195. Item Responses and Biserial Correlations
for Experimental and Control Groups

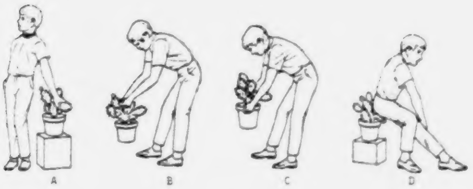
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	17-A	78	5	4	64	27	0	0	85	2	2	54	41	0	0	.47	.47
	17-B	85	4	93	4	0	0	0	78	1	94	1	1	1	1	.41	.83
Control	17-A	84	6	1	63	30	0	0	82	1	4	57	38	0	0	.20	.44
	17-B	82	2	94	2	0	0	1	84	0	95	2	1	1	0	.37	.84

Table 196. Pretest to Posttest Changes
(The response choice for 17-A is cited first.)

Item Pair 17-A, 17-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	A	A+A	B	D	B+D	D	C	D+C
Experimental	-10	+1	-5	-3	-3	-2	-2	+1	0	+14	-3	+6
Control	-6	+1	-2	-5	-2	-4	+3	+1	+1	+8	0	+4

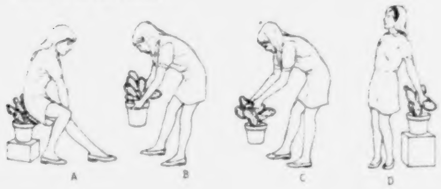
19A

WHICH OF THE FOLLOWING BOYS REMEMBERS THAT CACTUS NEEDLES ARE SHARP?
MARK AN X ON THAT PICTURE.



WHICH OF THE FOLLOWING GIRLS REMEMBERS THAT CACTUS NEEDLES ARE SHARP?
MARK AN X ON THAT PICTURE.

21B



Item pair 19-A, 21-B functions at the cognitive level of comprehension and is judged to provide baseline information. Mean total gain from pretest to posttest for the experimental group was eight percent (from 72 to 80 percent). Mean net gain for the control group was three percent (from 80 to 83 percent). Because of the greater improvement, we attribute the experimental group gain to the effect of instruction and account for the gains by losses on all other response choices. Biserial correlations indicate that both items are excellent discriminators.

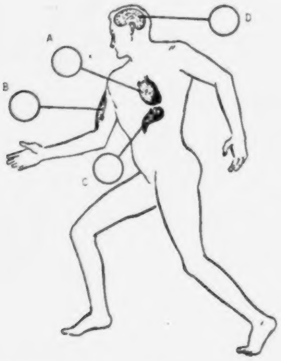
Table 197. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	19-A	78	4	3	68	24	0	1	85	1	2	81	15	0	0	.27	.54
	21-B	85	14	76	4	5	1	0	78	12	79	3	6	0	0	.24	.34
Control	19-A	84	2	0	76	19	2	0	82	2	2	87	7	0	1	.54	.47
	21-B	82	7	84	0	7	1	0	84	14	80	2	4	0	0	.42	.70

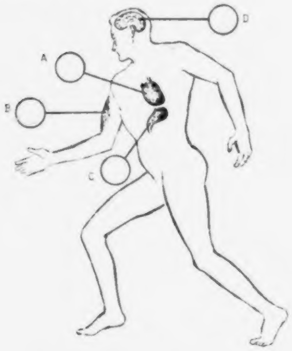
Table 198. Pretest to Posttest Changes
(The response choice for 19-A is cited first.)

Item Pair 19-A, 21-B	Percent Change Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	D	A+D	B	C	B+C	D	A	D+A
Experimental	+13	+3	+8	-3	+1	-2	-1	-1	-2	-9	-2	-5
Control	+11	-4	+3	0	-3	-1	+2	+2	+2	-12	+7	-2

WHAT RECEIVES MESSAGES FROM ALL OF THE SENSES? 23A
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHAT RECEIVES MESSAGES FROM ALL OF THE SENSES? 15B
MARK AN X IN THE CIRCLE ON THE LINE THAT
TOUCHES THAT PART.



Item pair 23-A, 15-B functions at the cognitive level of comprehension and was judged to provide baseline information. Mean net gain from pretest to posttest for the experimental group was 14 percent (from 79 to 93 percent). Mean net gain for the control group was 4 percent (from 72 to 76 percent). We can therefore attribute the experimental group

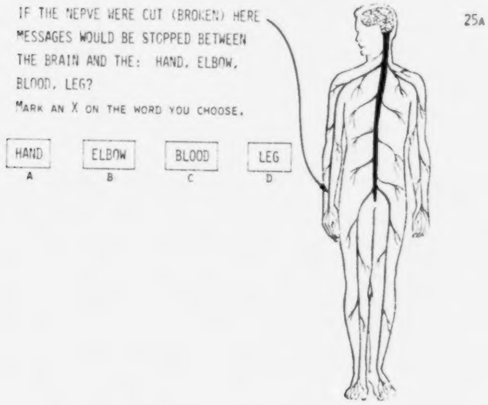
Table 199. Item Responses and Biserial Correlations
for Experimental and Control Groups

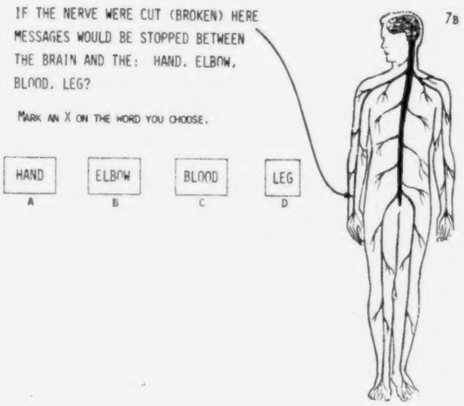
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	23-A	78	8	3	12	78	0	0	85	0	0	4	96	0	0	.74	.71
	15-B	85	9	5	6	80	0	0	78	4	5	0	90	1	0	.49	.87
Control	23-A	84	7	10	6	76	1	0	82	9	6	10	73	0	2	.56	.64
	15-B	82	17	7	6	67	0	2	84	12	5	4	80	0	0	.68	.64

Table 200. Pretest to Posttest Changes
(The response choice for 23-A is cited first.)

Item Pair 23-A, 15-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	B	B+B	C	C	C+C
Experimental	+18	+10	+14	-8	-5	-7	-3	0	-2	-8	-6	-7
Control	-3	+13	+4	+2	-5	-1	-4	-2	-3	+4	-2	+1

gains to the effect of instruction. For the experimental group, losses occurred on all response choices except the correct choice. It is evident that the role of the brain is emphasized in *ME NOW* and that the students have learned its role. Biserial correlations are outstanding for both groups.


IF THE NERVE WERE CUT (BROKEN) HERE
MESSAGES WOULD BE STOPPED BETWEEN
THE BRAIN AND THE: HAND, ELBOW, BLOOD, LEG?
MARK AN X ON THE WORD YOU CHOOSE.
25A
HAND
A
ELBOW
B
BLOOD
C
LEG
D


IF THE NERVE WERE CUT (BROKEN) HERE
MESSAGES WOULD BE STOPPED BETWEEN
THE BRAIN AND THE: HAND, ELBOW, BLOOD, LEG?
MARK AN X ON THE WORD YOU CHOOSE.
7B
HAND
A
ELBOW
B
BLOOD
C
LEG
D

Item pair 25-A, 7-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 15 percent (from 46 to 61 percent). There was a mean net loss of five percent (from 42 to 37 percent) for the control group, enabling us to attribute experimental group gains to the effect of instruction. Student achievement was much better with this illustration than with the less realistic one utilized in item pair 10-A, 25-B. Biserial correlations indicate that both items are good discriminators.

Table 201. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	25-A	78	50	22	14	10	4	0	85	56	20	13	4	5	2	.64	.48
	7-B	85	42	13	34	8	2	0	78	67	14	15	1	3	0	.45	.61
Control	25-A	84	43	20	20	15	1	0	82	41	28	17	10	2	1	.41	.38
	7-B	82	30	13	29	24	2	0	84	44	14	27	12	2	0	.60	.46

Table 202. Pretest to Posttest Changes
(The response choice for 25-A is cited first.)

Item Pair 25-A, 7-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experimental	+6	+25	+15	-2	+1	0	-1	-19	-10	-6	-7	-6
Control	-13	+3	-5	+8	+1	+4	-3	-2	-2	-5	-12	-8

Objective 303. Students will associate sensory perception with learning and behavior. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 13 to 15, 75 percent of the teachers reported that they used the strategies as described; 25 percent reported some modification. Ninety-four percent reported that the strategies were successful. Teacher comments indicated that the students were highly motivated in this sequence of activities. One typical report was, "Boys 3104 and 3106 were invited into the primary EMR room to conduct a lesson with the youngsters. They did a tremendous job -- and with very little help from the room teachers, carried the project all the way -- even to directing and helping the little ones to make their own ink blots."

Another teacher reported, "Activity #13 was really valuable not only scientifically but also psychologically and socially. There were all kinds of information available not only to the students but to the teacher about the students. So far I am so pleased with this program that it is unbelievable. Unit III is really great. I feel that a real contribution has been made to my field."

Some minor problems occurred in obtaining the film, Garbage, but instructions on ordering in the revised materials should eliminate this problem. Some teachers reported that a few students were frustrated by the maze, but most of them handled it successfully.

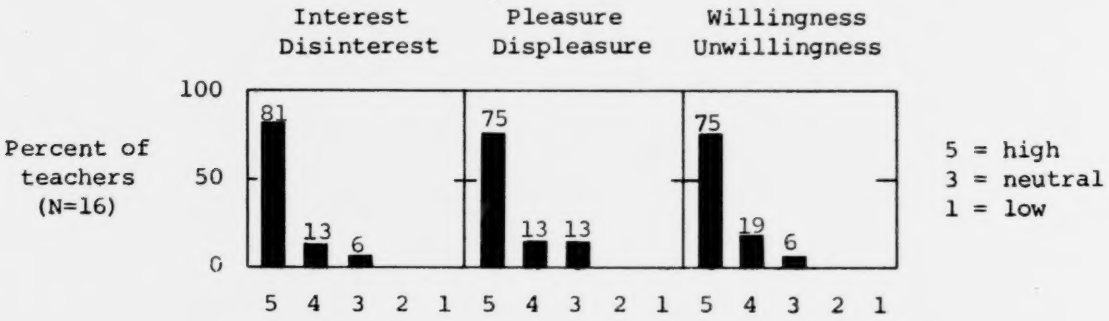


Figure 106. Reaction of the majority of students to activities 13 to 15.

Figure 106 shows that student reactions to the activities were very high across the three rating scales. Figure 107 shows that teachers rated the activities as very important for EMH students.

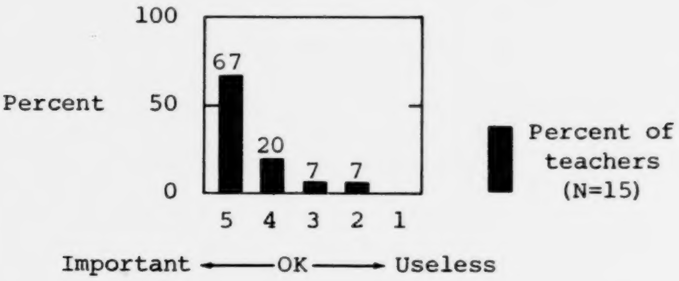
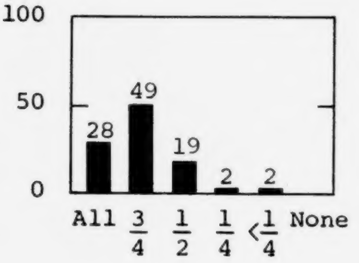


Figure 107. Importance to students of activities 13 to 15.

Figure 108 shows that students were very successful in these activities. Seventy-seven percent of the teachers reported that three-fourths or more of their students were able to perform the desired behaviors in the three subobjectives; 97 percent reported that one-half or more of their students were successful. Figure 109 shows that teachers considered the subobjectives to be important.



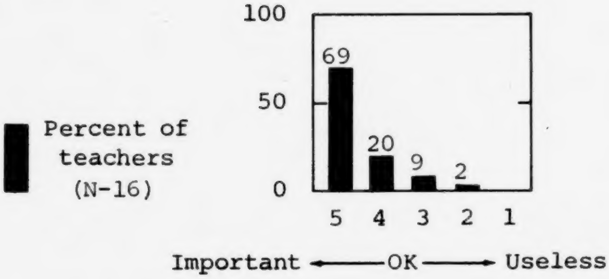
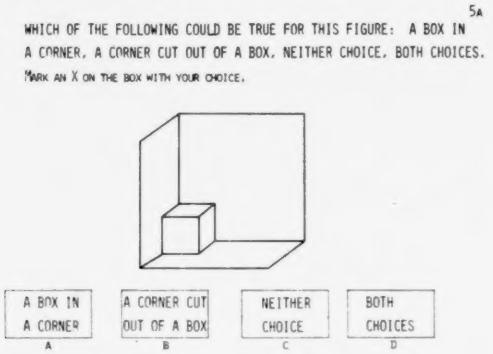


Figure 108. Proportion of students able to perform on subobjectives of objective 303.

Figure 109. Importance of the subobjectives.

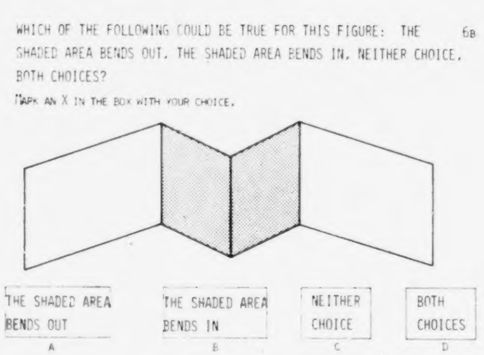
Four item pairs were designed to assess student achievement on objective 303.



5A

WHICH OF THE FOLLOWING COULD BE TRUE FOR THIS FIGURE: A BOX IN A CORNER, A CORNER CUT OUT OF A BOX, NEITHER CHOICE, BOTH CHOICES.
MARK AN X ON THE BOX WITH YOUR CHOICE.

A BOX IN A CORNER — A
A CORNER CUT OUT OF A BOX — B
NEITHER CHOICE — C
BOTH CHOICES — D



6B

WHICH OF THE FOLLOWING COULD BE TRUE FOR THIS FIGURE: THE SHADED AREA BENDS OUT, THE SHADED AREA BENDS IN, NEITHER CHOICE, BOTH CHOICES?
MARK AN X IN THE BOX WITH YOUR CHOICE.

THE SHADED AREA BENDS OUT — A
THE SHADED AREA BENDS IN — B
NEITHER CHOICE — C
BOTH CHOICES — D

Item pair 5-A, 6-B functions at the cognitive level of analysis. For the experimental group there was a mean net loss from pretest to posttest of 11 percent (from 35 to 24 percent). For the control group there was a mean net gain of 11 percent (from 19 to 30 percent). For both groups the response pattern appeared to be that of random responses.

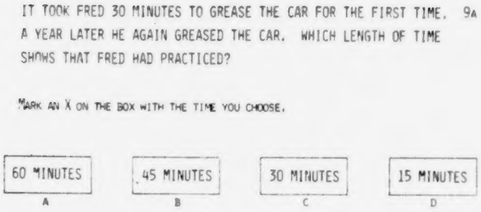
Table 203. Item Responses and Biserial Correlations for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	5-A	78	47	19	5	26	1	1	85	53	21	4	21	0	1	.18	.15
	6-B	85	24	29	2	44	0	0	78	27	36	9	27	0	0	.09	.30
Control	5-A	84	45	29	7	15	2	1	82	44	23	7	22	1	2	.20	.18
	6-B	82	28	35	9	23	5	0	84	26	24	7	38	5	0	.08	.48

Table 204. Pretest to Posttest Changes
(The response choice for 5-A is cited first.)

Item Pair 5-A, 6-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	B	B	B+B	C	C	C+C
Experimental	-5	-17	-11	+6	+3	+4	+2	+7	+4	-1	+7	+3
Control	+7	+15	+11	-1	-2	-2	-6	-11	-8	0	-2	-1

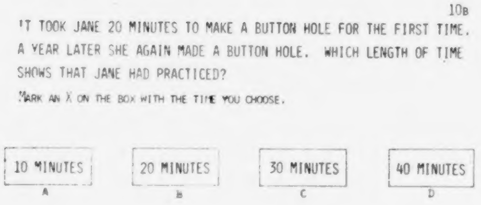
The shading on the box should be improved and it appears that more emphasis should be placed on this type of activity for the revised materials.



IT TOOK FRED 30 MINUTES TO GREASE THE CAR FOR THE FIRST TIME. 9A
A YEAR LATER HE AGAIN GREASED THE CAR. WHICH LENGTH OF TIME
SHOWS THAT FRED HAD PRACTICED?

MARK AN X ON THE BOX WITH THE TIME YOU CHOOSE.

60 MINUTES A
45 MINUTES B
30 MINUTES C
15 MINUTES D



10B
IT TOOK JANE 20 MINUTES TO MAKE A BUTTON HOLE FOR THE FIRST TIME.
A YEAR LATER SHE AGAIN MADE A BUTTON HOLE. WHICH LENGTH OF TIME
SHOWS THAT JANE HAD PRACTICED?

MARK AN X ON THE BOX WITH THE TIME YOU CHOOSE.

10 MINUTES A
20 MINUTES B
30 MINUTES C
40 MINUTES D

Item pair 9-A, 10-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was 12 percent (53 to 65 percent) while the gain for the control group was 16 percent (from 48 to 64 percent). Inspection of gains and biserial

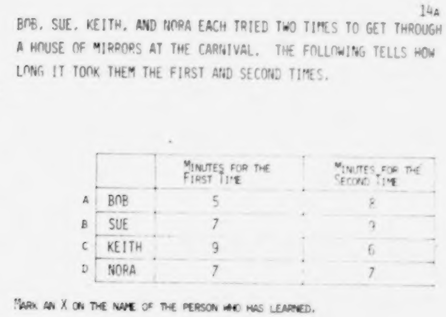
Table 205. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	9-A	78	26	12	10	53	0	0	85	14	8	12	65	0	1	.66	.54
	10-B	85	53	15	6	26	0	0	78	64	8	12	17	0	0	.49	.53
Control	9-A	84	27	10	21	40	1	0	82	26	12	10	51	0	1	.54	.61
	10-B	82	57	9	6	24	2	1	84	76	8	4	11	1	0	.56	.78

Table 206. Pretest to Posttest Changes
(The response choice for 9-A is cited first.)

Item Pair 9-A, 10-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	C	B+C	C	B	C+B
Experimental	+12	+11	+12	-12	-9	-10	-4	+6	+1	+2	-7	-3
Control	+11	+19	+16	-1	-13	-8	+2	-2	0	-11	-1	-6

correlations lead us to hypothesize that instruction covering this topic occurred in the control group. Regardless of whether or not the experimental group gains can be attributed to the effect of instruction, they were significant and we are satisfied with the level of achievement.

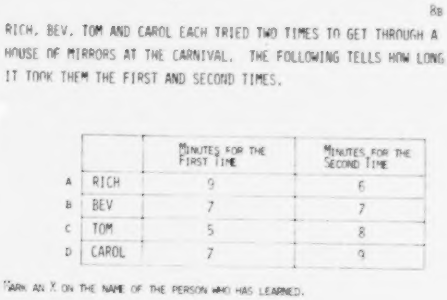


14A

BOB, SUE, KEITH, AND NORA EACH TRIED TWO TIMES TO GET THROUGH A HOUSE OF MIRRORS AT THE CARNIVAL. THE FOLLOWING TELLS HOW LONG IT TOOK THEM THE FIRST AND SECOND TIMES.

		MINUTES FOR THE FIRST TIME	MINUTES FOR THE SECOND TIME
A	BOB	5	8
B	SUE	7	9
C	KEITH	9	6
D	NORA	7	7

MARK AN X ON THE NAME OF THE PERSON WHO HAS LEARNED.



8B

RICH, BEV, TOM AND CAROL EACH TRIED TWO TIMES TO GET THROUGH A HOUSE OF MIRRORS AT THE CARNIVAL. THE FOLLOWING TELLS HOW LONG IT TOOK THEM THE FIRST AND SECOND TIMES.

		MINUTES FOR THE FIRST TIME	MINUTES FOR THE SECOND TIME
A	RICH	9	6
B	BEV	7	7
C	TOM	5	8
D	CAROL	7	9

MARK AN X ON THE NAME OF THE PERSON WHO HAS LEARNED.

Item pair 14-A, 8-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest for the experimental group was six percent (from 36 to 42 percent), while the gain for the control group was nine percent (from 35 to 44 percent). This is an alternative

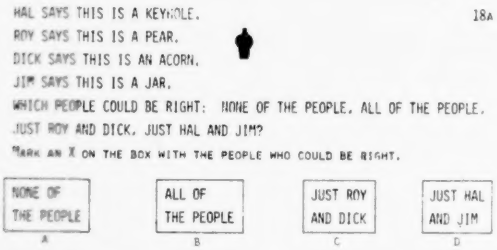
Table 207. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	14-A	78	29	14	33	18	0	5	85	29	13	35	15	0	7	.31	.50
	8-B	85	39	14	27	15	2	2	78	50	10	21	15	1	3	.19	.40
Control	14-A	84	27	13	32	23	1	4	82	23	13	46	13	0	4	.40	.38
	8-B	82	39	20	13	22	4	2	84	42	18	19	15	0	6	.03	.57

Table 208. Pretest to Posttest Changes
(The response choice for 14-A is cited first.)

Item Pair 14-A, 8-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	A	C	A+C	B	D	B+D	D	B	D+B
Experimental	+2	+11	+6	0	-6	-3	-1	0	-1	-3	-4	-3
Control	+14	+3	+9	-4	+6	+1	0	-7	-3	-10	-2	-6

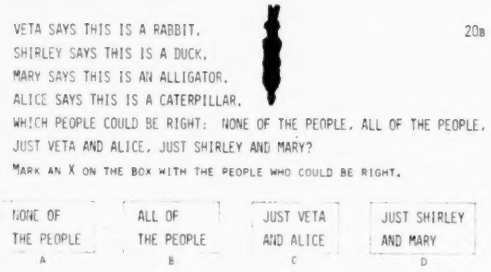
form for presenting data similar to the previous item pair, but this system appears to be more difficult for the EMH students to interpret. Learning did occur in both the experimental and control groups.



18A

HAL SAYS THIS IS A KEYHOLE.
ROY SAYS THIS IS A PEAR.
DICK SAYS THIS IS AN ACORN.
JIM SAYS THIS IS A JAR.
WHICH PEOPLE COULD BE RIGHT: NONE OF THE PEOPLE. ALL OF THE PEOPLE. JUST ROY AND DICK. JUST HAL AND JIM?
MARK AN X ON THE BOX WITH THE PEOPLE WHO COULD BE RIGHT.

☐ NONE OF THE PEOPLE A
☐ ALL OF THE PEOPLE B
☐ JUST ROY AND DICK C
☐ JUST HAL AND JIM D



20B

VETA SAYS THIS IS A RABBIT.
SHIRLEY SAYS THIS IS A DUCK.
MARY SAYS THIS IS AN ALLIGATOR.
ALICE SAYS THIS IS A CATERPILLAR.
WHICH PEOPLE COULD BE RIGHT: NONE OF THE PEOPLE. ALL OF THE PEOPLE. JUST VETA AND ALICE. JUST SHIRLEY AND MARY?
MARK AN X ON THE BOX WITH THE PEOPLE WHO COULD BE RIGHT.

☐ NONE OF THE PEOPLE A
☐ ALL OF THE PEOPLE B
☐ JUST VETA AND ALICE C
☐ JUST SHIRLEY AND MARY D

Item pair 18-A, 20-B functions at the cognitive level of evaluation. Mean net gain from pretest to posttest for the experimental group was 13 percent (from 12 to 25 percent), while gain for the control group was two percent (from 15 to 17 percent). We attribute the experimental

Table 209. Item Responses and Biserial Correlations
for Experimental and Control Groups

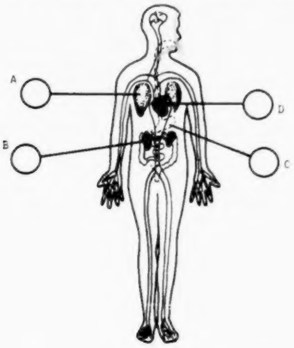
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	18-A	78	26	12	15	45	1	1	85	19	28	21	32	0	0	-.38	.07
	20-B	85	40	12	31	14	4	0	78	44	21	24	10	1	0	-.12	.14
Control	18-A	84	31	17	14	36	2	0	82	24	22	22	27	4	1	-.29	.41
	20-B	82	38	13	22	18	6	2	84	44	13	26	17	0	0	.28	-.08

Table 210. Pretest to Posttest Changes
(The response choice for 18-A is cited first.)

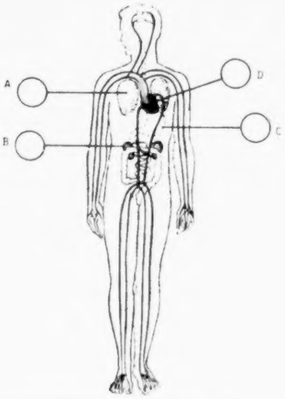
Item Pair 18-A, 20-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	C	C+C	D	D	D+D
Experi-mental	+16	+9	+13	-7	+4	-2	+6	-7	-1	-13	-4	-8
Control	+5	0	+2	-7	+6	0	+8	+4	+6	-9	-1	-5

group gains to the effect of instruction, but the low level of achievement indicates that more emphasis should be placed on helping students understand that it is possible for each person to view a figure and interpret differently than any other person.

WHICH IS A PART OF THE DIGESTIVE SYSTEM? 21A
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHICH IS A PART OF THE BLOOD PUMPING SYSTEM? 18B
MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



One item pair, 21-A, 18-B is an item measuring achievement from Unit I to determine if students are remembering information from last Fall.

Table 211. Item Responses and Biserial Correlations
for Experimental and Control Groups

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	21-A	78	6	23	60	10	0	0	85	7	28	53	12	0	0	.55	.55
	18-B	85	8	2	10	79	0	0	78	5	1	3	91	0	0	.60	.60
Control	21-A	84	8	35	35	23	0	0	82	7	32	41	17	0	2	.38	.56
	18-B	82	7	10	13	67	0	2	84	7	5	7	80	1	0	.48	.22

Table 212. Pretest to Posttest Changes
(The response choice for 21-A is cited first.)

Item Pair 21-A, 18-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	D	C+D	A	A	A+A	B	B	B+B	D	C	D+C
Experimental	-7	+12	+2	+1	-3	-1	+5	-1	+3	+2	-7	-2
Control	+6	+13	+10	-1	0	-1	-3	-5	-5	-6	-6	-6

Item pair 21-A, 18-B functions at the cognitive level of comprehension. The pretest and posttest levels of achievement of 70 and 72 percent, respectively, for the experimental group are entirely satisfactory. It appears that the EMH students in our sample are retaining information they have learned.

Objective Achievement Tests

Descriptive Data and Interpretation. Pretests were administered to experimental classes between February 2 and March 31, 1971 and to control classes between February 10 and March 15, 1971. A continued difference in the amount of time devoted to science instruction resulted again in widely spread posttest administration dates for the experimental group. The earliest was March 8 and the latest May 5, 1971. Control group posttests were administered between March 19 and May 20, 1971.

Raw score frequency distributions on the tests for both experimental and control classes are shown in Table 213. Tables 214 and 215 provide more detailed descriptive data on pretest and posttest scores and on residual gain scores, calculated with the raw regression coefficient for the combined experimental and control classes. The interpretations that follow are based on the data provided in these tables.

Table 213. Frequency Distribution of Raw Scores for Test Forms A and B, Experimental and Control Groups, Unit III

	Experimental Groups				Control Groups			
Raw Scores	Pre A	Post B	Pre B	Post A	Pre A	Post B	Pre B	Post A
24-25		1		1				
22-23		5	1	5	1	7		1
20-21	3	14	5	8	2	5		3
18-19	11	23	13	19	8	18	5	6
16-17	13	14	15	20	18	17	12	16
14-15	19	10	17	14	16	10	23	16
12-13	12	5	16	7	17	14	11	20
10-11	6		12	4	11	3	14	11
8-9	8	4	5	2	7	4	9	6
6-7	5	2	1	3	4	4	4	1
4-5	1			1		1	2	1
2-3						1	1	1
0-1							1	
Totals	78	78	85	85	84	84	82	82

1. Experimental classes using pretest Form A registered means above and below the range of the standard error of measurement; the mean of one experimental class using pretest Form B was below the standard error or measurement, indicating different levels of student knowledge prior to instruction in Unit III. Because of this result, covariance analysis with pretest and posttest scores and/or analysis of variance using residual gain scores will be necessary for any comparisons of student achievement among experimental classes.

Table 214. Experimental Group Pretest, Posttest, and Residual Gain Data
Unit III, *ME NOW*, Movement, Support, and Sensory Perception

	PRETEST							POSTTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range	
																	Min.	Max.
Form A 21	5	13.20	52.80	3.96		1.77	8-17	14.80	59.20	3.77		1.69	9-19	-0.41	2.23	0.99	-2.58	2.22
22	10	12.20	48.80	3.85		1.22	6-16	16.40	65.60	3.95		1.25	8-21	1.94	3.36	1.06	-2.82	7.73
23	11	13.55	54.20	2.98		0.90	9-19	17.73	70.92	3.44		1.04	9-21	2.25	2.72	0.82	-3.03	5.97
24	9	9.67	38.68	3.00		1.00	6-15	14.11	56.44	4.34		1.45	6-18	1.58	3.36	1.12	-3.75	5.49
25	10	15.00	60.00	3.06		0.97	9-19	18.10	72.40	1.45		0.46	16-20	1.52	1.38	0.44	-0.62	3.97
26	14	17.79	71.16	1.85		0.49	15-21	20.43	81.72	1.65		0.44	17-23	1.73	1.74	0.46	-0.34	6.42
27	11	12.00	48.00	3.03		0.91	5-15	15.55	62.20	4.61		1.39	6-25	1.24	3.51	1.06	-2.99	8.42
28	8	15.50	62.00	3.55		1.25	11-20	17.00	68.00	2.78		0.98	14-22	0.04	1.92	0.68	-2.58	2.46
All A	78	13.83	55.32	3.85	0.70	2.08*	5-21	17.10	68.40	3.77	0.73	1.91*	6-25	1.41	2.64	0.30	-3.75	8.42
Form B 31	8	15.88	63.52	4.36		1.54	7-21	17.38	69.52	3.54		1.25	12-22	0.13	2.33	0.82	-3.82	3.66
32	11	12.18	48.72	2.82		0.85	8-17	13.64	54.56	4.78		1.44	5-20	-0.81	3.86	1.16	-8.06	3.70
33	12	15.08	60.32	3.85		1.11	8-18	16.42	65.68	4.08		1.18	8-22	-0.23	2.97	0.86	-5.54	4.73
34	11	15.82	63.28	2.96		0.89	11-21	17.00	68.00	3.00		0.90	11-23	-0.20	1.63	0.49	-2.54	2.42
35	10	12.80	51.20	2.66		0.84	9-17	13.80	55.20	3.91		1.24	7-19	-1.11	3.32	1.05	-6.30	3.94
36	11	16.00	64.00	3.16		0.95	10-22	18.36	73.44	3.26		0.98	14-25	1.02	2.87	0.86	-5.62	5.18
37	14	13.64	54.56	2.65		0.71	10-20	15.71	62.84	3.75		1.00	6-21	0.16	2.72	0.73	-6.78	4.18
38	8	15.38	61.52	3.89		1.38	11-20	17.75	71.00	3.37		1.19	12-22	0.88	2.02	0.71	-2.62	3.46
All B	85	14.52	58.08	3.44	0.59	2.15*	7-22	16.18	64.72	3.96	0.74	1.98*	5-25	-0.04	2.79	0.30	-8.06	5.18
All	163	14.19	56.76	3.65		0.29	5-22	16.62	66.48	3.89		0.30	5-25	0.65	2.81	0.22	-8.06	8.42
Boys	110	14.87	59.48	3.65		0.35	5-22	17.15	68.60	3.72		0.35	6-25	0.67	2.62	0.25	-6.78	8.42
Girls	53	12.77	51.08	3.23		0.44	6-19	15.51	62.04	4.03		0.55	5-21	0.62	3.18	0.44	-8.06	7.73

*Standard error of estimate (σ_s) for individual scores.

Table 215. Control Group Pretest, Posttest, and Residual Gain Data
Unit III, *ME NOW*, Movement, Support, and Sensory Perception

	PRETEST							POSTTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range	
																	Min.	Max.
Form A 81	12	9.75	39.00	2.70		0.78	6-15	9.50	38.00	3.42		0.99	3-14	-3.09	3.73	1.08	-9.58	2.73
82	7	12.00	48.00	3.00		1.13	8-16	16.71	66.84	4.72		1.78	8-22	2.41	3.12	1.18	-4.03	6.18
83	12	13.00	52.00	2.52		0.73	7-17	14.42	57.68	3.34		0.97	7-20	-0.65	2.69	0.78	-5.10	4.18
84	14	17.00	68.00	2.72		0.73	12-22	20.29	81.16	2.20		0.59	16-23	2.18	1.87	0.50	-0.86	5.66
85	9	15.22	60.88	3.77		1.26	8-20	15.11	60.44	3.26		1.09	8-19	-1.64	3.03	1.01	-6.30	2.18
86	9	13.00	52.00	3.35		1.12	9-18	13.56	54.24	3.88		1.29	7-18	-1.51	2.80	0.93	-5.86	2.70
87	11	13.64	54.56	2.38		0.72	9-17	15.18	60.72	2.04		0.62	12-19	-0.36	2.59	0.78	-4.10	3.70
88	10	15.10	60.40	2.38		0.75	11-19	17.80	71.20	1.75		0.55	16-22	1.14	2.30	0.73	-2.62	5.42
All A	84	13.69	54.76	3.51	0.63	2.09*	6-22	15.37	61.48	4.37	0.78	1.99*	3-23	-0.22	3.24	0.35	-9.58	6.18
Form B 91	9	14.33	57.32	3.12		1.04	9-19	17.67	70.68	2.92		0.97	12-23	1.59	2.28	0.76	-1.54	4.97
92	6	15.17	60.68	2.48		1.01	12-17	15.83	63.32	2.64		1.08	12-20	-0.88	2.55	1.04	-3.10	2.70
93	10	12.60	50.40	2.84		0.90	9-18	14.60	58.40	3.53		1.12	8-19	-0.15	3.96	1.25	-8.58	3.97
94	11	9.55	38.20	4.13		1.25	3-16	12.18	48.72	3.57		1.08	5-16	-0.26	3.21	0.97	-3.82	5.49
95	6	10.83	43.32	6.55		2.68	1-19	10.83	43.32	4.88		1.99	2-15	-2.58	1.46	0.59	-4.62	-0.75
96	10	12.70	50.80	3.09		0.98	9-17	13.40	53.60	3.03		0.96	10-20	-1.44	2.56	0.81	-5.10	3.42
97	16	12.94	51.76	2.77		0.69	7-17	12.63	50.52	2.73		0.68	7-17	-2.39	2.13	0.53	-4.58	1.97
98	14	12.79	51.16	3.89		1.04	5-19	13.14	52.56	2.85		0.76	9-20	-1.76	2.46	0.66	-6.10	2.01
All B	82	12.55	50.20	3.78	0.67	2.12*	1-19	13.65	54.60	3.58	0.64	2.09*	2-23	-1.07	2.86	0.32	-8.58	5.49
All	166	13.13	52.52	3.68		0.29	1-22	14.52	58.08	4.08		0.32	2-23	-0.64	3.08	0.24	-9.58	6.18
Boys	103	12.88	51.52	3.61		0.36	1-20	14.31	57.24	3.99		0.39	2-23	-0.66	3.07	0.30	-9.58	5.66
Girls	63	13.52	54.08	3.78		0.48	3-22	14.86	59.44	4.23		0.53	3-23	-0.60	3.12	0.39	-7.51	6.18

*Standard error of estimate (σ_s) for individual scores.

2. Posttest means for Forms A and B were also outside the range of the standard error of measurement, but posttest reliabilities were above the minimum acceptable level of .70. Eleven of 16 experimental classes showed positive mean residual gain scores and those with negative means were not seriously low. A multiple stepwise regression was performed to determine the effects of the independent variables on posttest scores. Analysis of variance on residual gain scores was also performed to confirm the results of analysis of covariance.
3. Means for control classes using both pretest forms were outside of the range of the standard error of measurement, indicating different levels of knowledge at the time of pretesting.
4. Posttest means for control classes were outside the limits of the standard error of measurement for both Form A and Form B. Three control classes, 82, 84 and 88 all scored very high mean residual gain scores, indicating that instruction probably took place in these classes between pretesting and posttesting. As was the case with Unit II, this result eliminates the possibility of using control classes to compute a test-retest reliability for Unit III. Also similar to Unit II and confirming our hypothesis of control group instruction, an examination of the control group test score frequency distribution (see Table 213) also indicates upward shifts.

Multiple Stepwise Regression Analysis

Experimental Group, Unit III. To determine the effect of the independent variables on posttest scores, the following question was investigated: "Is there a significant difference in the level of achievement on the posttest among students in EMH classes having different background variables?"

The following independent variables were used to test this question: sex, age, WISC Full Scale IQ, race, teachers' assessment of reading achievement, teachers' assessment of verbal participation, and pretest score. All scores from Form A and Form B were pooled and treated as the results from one test.

The results for the posttest administered to the 163 students in the Unit III experimental group are summarized in Table 216. The F-level of race was not high enough to enter into the regression equation.

Table 216. Results of Multiple Linear Regression Analysis, Experimental Group, Unit III.

Independent Variable	β_i	$S\beta_i$	F
Sex	-0.1895	.4720	0.1612
Age	0.0031	.0151	0.0418
WISC Total IQ	0.1079	.0308	12.2815**
Reading Achievement	0.3487	.1881	3.4356
Verbal Participation	-0.0364	.1964	0.0343
Pretest	0.5805	.0753	59.3864**

**Significant at the .001 level, $F_{.001(1,156)} = 10.83$

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the posttest instrument.

Discussion

The data indicate that sex, age, race, teachers' assessment of reading achievement and teachers' assessment of verbal participation are not significant predictors of success on the posttest. WISC Total IQ and the pretest score are very high predictors of success on the posttest (P<.001). These results are essentially the same as those obtained for the previous units, except that IQ and pretest scores are the only significant predictors for Unit III. An analysis of variance was computed to determine the exact relationship between IQ scores and success on the posttest.

Table 217. Matrix of Correlation Coefficients Experimental Group, Unit III

	Age	Total IQ	Race	Reading Achievement	Verbal Participation	Pretest	Posttest
Sex	-.108	-.156	-.039	.082	-.045	-.271	-.199
Age		-.065	-.212	.286	.080	.364	.231
Total IQ			-.059	.270	.287	.482	.534
Race				-.093	-.195	-.096	-.076
Reading Achievement					.388	.201	.290
Verbal Participation						.198	.213
Pretest							.692

The effect of the pretest accounts for approximately 47.9 percent of the variance in the regression equation, which is higher than either Unit I or Unit II. The combination of pretest and WISC Total IQ account for 53.1 percent of the variance, which is also an improvement over Units I and II. The inclusion of all of the variables except race accounts for 54.4 percent of the variance in the regression equation, as contrasted with 45.8 percent for Unit II and 53.5 percent for Unit I.

Table 218. Multiple Stepwise Regression Analysis
Experimental Group, Unit II

Step Number	Variable Entered	Multiple r	r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables
1	Pretest	.6924	.4794	.4794	148.2794	1
2	Total IQ	.7289	.5314	.0519	17.7249	2
3	Reading Achievement	.7372	.5434	.0121	4.2085	3
4	Sex	.7375	.5439	.0005	.1709	4
5	Age	.7376	.5441	.0001	.0444	5
6	Verbal Participation	.7377	.5442	.0001	.0343	6

Objective Achievement Tests

Analyses of Variance and Covariance, Experimental Group, Unit III. Two different statistical analyses were performed to investigate the question, "Is there a significant difference between experimental classes in the level of achievement on the Unit III posttest?" The results of an analysis of covariance are summarized in Table 219. These results

Table 219. Analysis of Covariance Between Classes
on Adjusted Unit III Posttest Means, Pretest as Covariate

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	11.2801	1.4899
Within Groups	146	7.5710	

No significant difference, $F_{.05(15,146)} = 1.67$

indicate that there are no significant differences between experimental classes on posttest means adjusted for differences in pretest scores.

Table 220 summarizes the means and standard deviations for pretests and posttests for each class in the experimental group.

Table 220. N, Means, Standard Deviations, and Adjusted Means of 16 Classes Experimental Group, Unit III

Class Number	N	Posttest Mean	Posttest Standard Deviations	Adjusted Posttest Mean	Pretest Mean
21	5	14.80	3.77	15.52	13.20
22	10	16.40	3.95	17.84	12.20
23	11	17.73	3.44	18.19	13.55
24	9	14.11	4.34	17.38	9.67
25	10	18.10	1.45	17.51	15.00
26	14	20.43	1.65	17.83	17.79
27	11	15.55	4.61	17.13	12.00
28	8	17.00	2.78	16.05	15.50
31	8	17.38	3.54	16.16	15.88
32	11	13.64	4.78	15.09	12.18
33	12	16.42	4.08	15.77	15.08
34	11	17.00	3.00	15.82	15.82
35	10	13.80	3.91	14.80	12.80
36	11	18.36	3.26	17.06	16.00
37	14	15.71	3.75	16.11	13.64
38	8	17.75	3.37	16.89	15.38

An analysis of variance on residual gain scores was performed to confirm the results of the analysis of covariance. The residual gain score used in this analysis was computed using the within-class pooled regression coefficient of experimental classes only. The results of the analysis of variance, indicating no significant difference between classes, are summarized in Table 221. This result confirms the results of the analysis of covariance.

Table 221. Analysis of Variance Between Classes on Residual Gain Scores Experimental Group, Unit III

Source	d.f.	Mean Square	F-Ratio
Between Groups	15	11.3154	1.5048
Within Groups	147	7.5194	

No significant difference, $F_{.05(15,147)} = 1.67$

Table 222 summarizes the means and standard deviations for residual gain scores for each class in the experimental group.

Table 222. Residual Gain, Class Data, Experimental Group, Unit III

Class Number	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
21	5	-1.06	2.23	1.00	1.60	-3.16	4.76
22	10	1.27	3.33	1.05	6.90	-3.43	10.33
23	11	1.62	2.72	0.82	5.18	-3.82	9.00
24	9	0.81	3.38	1.13	4.62	-4.65	9.27
25	10	0.94	1.29	0.41	3.18	-1.05	4.23
26	14	1.26	1.71	0.46	5.84	-0.88	6.72
27	11	0.56	3.53	1.06	3.73	-3.93	7.66
28	8	-0.52	1.88	0.66	1.57	-3.16	4.73
31	8	-0.41	2.29	0.81	3.12	-4.43	7.55
32	11	-1.48	3.88	1.17	3.01	-8.71	11.72
33	12	-0.80	2.96	0.85	3.90	-6.27	10.17
34	11	-0.75	1.65	0.50	1.84	-3.27	5.11
35	10	-1.77	3.32	1.05	3.29	-6.99	10.28
36	11	0.48	2.84	0.86	4.57	-6.05	10.62
37	14	-0.46	2.75	0.73	3.12	-7.54	10.66
38	8	0.32	2.01	0.71	2.73	-3.05	5.78

Discussion

Teachers adhered more strictly to teaching strategies in Unit III than in Unit II and once again, as was the case with Unit I, no significant differences were found between classes. In view of these results, it seems very important that teachers using the revised edition of *ME NOW* be given some kind of pre-service or in-service training to familiarize them with the philosophy and rationale of the program.

One-Way Analysis of Variance Experimental Group, Unit III. The results of the multiple linear regression on the posttest indicated that WISC Total IQ was a significant predictor of success on the posttest. To further investigate this result and to minimize the effect of the regression to the posttest mean, the following question was investigated: "Is there a significant difference in residual gain scores between students blocked on 3 levels of WISC Full Scale IQ scores?"

Residual gain scores for 163 students with WISC Full Scale IQ data were blocked on three different levels of IQ scores: 66 and less, 67 to 79, and 80 and above. An analysis of variance was performed on the residual gain scores in this one-way ANOVA design. Table 223 summarizes the results of the analysis of variance, indicating that there is a significant difference between students in the three IQ levels.

Table 223. ANOVA, Residual Gain Blocked on WISC Full Scale IQ Experimental Group, Unit III

Source	d.f.	Mean Square	F-Ratio
Between Groups	2	52.4699	7.1744**
Within Groups	160	7.3134	

**Significant at .001 level, $F_{.001(2,160)} = 6.91$

Table 224 summarizes the means and standard deviations for each of the three cells in the model.

Table 224. Cell Means and Standard Deviations Blocked Data, Unit III

IQ Level	N	Mean	Standard Deviation
80+	29	0.99	1.86
67-79	99	0.28	2.59
≤ 66	35	-1.40	3.49

Discussion

The results of the analysis of variance indicate that there is a significant difference between students whose IQ scores are above 66 and those whose IQ scores are 66 and below ($P<.001$). This result indicates that the students for whom the materials were designed, those whose IQ scores are between 65 and 80, are experiencing success with the use of *ME NOW*. Similar to the results on previous units, students in the low IQ group (≤ 66) do not perform as well as those students with higher IQ scores. One different result in Unit III testing was that those students with IQ scores between 67 and 79 did not attain higher residual gain scores than students whose IQ scores were 80 and above. The need for suggestions to the teacher on how to use *ME NOW* for students whose IQ is below 66 is further emphasized by the results from Unit III.

Experimental-Control Group Analyses. To investigate the question, "Is there a significant difference in student achievement between the experimental and control groups?" residual gain scores were computed using the raw regression coefficient, obtained by pooling all experimental and control students, and an analysis of variance was performed. Table 225 summarizes the mean residual gain scores and standard deviations for both groups.

Table 225. Residual Gain Means and Standard Deviations
Experimental and Control Groups, Unit III

Group	N	Mean	Standard Deviation
Experimental	163	0.65	2.81
Control	166	-0.64	3.08

Table 226 summarizes the results of the analysis of variance, indicating a significant difference between the experimental and control groups (P<.001).

Table 226. ANOVA, Experimental and Control
Residual Gain Scores, Unit III

Source	d.f.	Mean Square	F-Ratio
Between Groups	1	137.6530	15.8526**
Within Groups	327	8.6833	

**Significant at the .001 level, $F_{.001(1,327)} = 10.83$

Discussion

The results of the analysis of variance indicate that there is a significant difference between the experimental and control groups on residual gain scores (P<.001). On the basis of these results, we concluded that the experimental Unit III materials did have an effect on EMH students, as assessed by the objective tests. Twenty-four of the 25 items on both forms assessed achievement on major objectives in Unit III; one pair of items measured recall from Unit I. Seven of the 24 Unit III items were judged to provide baseline information, and 17 were considered to be good indicators of student growth from pretest to posttest.

Factor Analysis. To determine the structure of the Unit III achievement tests, a Harris-Kaiser oblique, unnormalized, orthogonal rotation was performed on the results of posttests A and B. For posttest A, 15 factors were identified which accounted for 47 percent of the variance. For posttest B, 16 factors were identified which accounted for 47 percent of the variance.

Table 227 presents the results for posttest A, showing only those factors with eigenvalues above 1. The objective measured and cognitive level of each item is included, as is a hypothetical name for each factor. The cognitive levels identified are the same as those used in the previous units.

Table 227. Factor Structure - Unit III, Posttest A

Factor	Items	Cognitive Level	Objective	Name
1	5	high	303	balance - visual
	13	low	300	interpretation
	18	high	303	
2	15	high	302	coordination - balance
	20	high	300	
3	1	knowledge	301	sense - protection
	22	low	300	
4	11	high	300	muscle action
	17	knowledge	302	

Table 228 presents the results of posttest B, showing only those factors with eigenvalues above 1.

For Unit III, item pair 22-A, 19-B was the only pair identified in the factors with eigenvalues above 1. Many of the other paired items appeared in factors with eigenvalues below 1. Items loading

Table 228. Factor Structure - Unit III, Posttest B

Factor	Items	Cognitive Level	Objective	Name
1	7	low	302	senses - protection
	12	low	301	
	13	knowledge	302	
	22	low	300	
2	19	low	300	protection
3	1	knowledge	301	senses - heartbeat
	4	knowledge	301	
	18	low	Unit I	

on the four factors of posttest A and the three factors of posttest B were well distributed across the test. There were more items dealing with the senses in posttest B factors (eigenvalues above 1) than in posttest A.

Summary

We can conclude that students in our sample learned from the experimental Unit III materials. Experimental group achievement was satisfactory and significantly higher than control group achievement. Students whose IQ scores were higher than 66 scored significantly higher than students whose IQ scores were 66 or below on adjusted posttest scores. Both teacher feedback and achievement test items identified areas of instruction where modifications were necessary. Student interest and enthusiasm remained high throughout the unit.

CHAPTER V

EVALUATION OF UNIT IV

GROWTH AND DEVELOPMENT

The Instructional Program

Instruction for 13 of the 16 experimental classes began from March 8 to May 14, 1971. Six of the 16 classes either did not use or did not complete Unit IV for various reasons. Three of these were unable to use the materials because of school board policies governing the study of human reproduction. The other three teachers did not have enough time left after completing Unit III to complete Unit IV and administer posttests. Because of the sensitive nature of the topic of human reproduction, most control group teachers did not want to administer the pretests and posttests unless some instruction could be given, which would eliminate using these classes as a control. Because of these difficulties, the decision was made not to use a control group for Unit IV.

The growth and development of a human being from the moment of conception through old age is the focus of Unit IV. It provides a focal point for integrating and synthesizing the dynamics of the entire life cycle. Instruction begins with a discussion on recognition of males and females, which leads into primary and secondary sex characteristics with the use of slides and posters. Stages of development from infancy to maturity are investigated using slides, which leads to a study of different rates of development within age groups. It is hoped that these differential rates of development will be understood by the EMH student to eliminate undue concern for the slowly developing child.

Eggs from different animals, including humans, are studied with the use of slides and worksheets. This leads into a study of female sex organs during adolescence. Ovulation and menstruation are studied and illustrated using an artificial model of female sex organs. The role of male sex organs during adolescence is the next topic followed by a discussion, with the aid of slides, of peer group attitudes and "proper" male and female behavior. The role of parents is investigated in a study about a family of geese. How an egg becomes fertilized by sperm from the male is studied with the aid of slides, worksheets and magnifying glasses. Development of the fetus within the mother is followed, again with the aid of slides, from conception through birth. Prenatal care is stressed, as is the proper care of infants.

The above topics lead into a discussion of factors needed for growth and development and the students construct charts of their growth in height and weight from birth to the present time. Heredity is introduced through the study of the students' and parents' height. Characteristics of people at different ages are investigated, and the unit terminates with a study of traits inherited from parents.

Effectiveness of Instruction: Data, Analysis, and Interpretation

Objective 400. Students will associate sexual distinction with body parts and characteristics. Three student activities and other instructional strategies were designed to develop student competencies to achieve this objective. The writers assumed that the students had little or no knowledge of the subject matter prior to instruction.

For activities 1 to 3, 69 percent of the teachers reported that they used the strategies as described; 31 percent reported some modification. All teachers indicated that the strategies were successful.

Teachers were unanimous in stating that most children were slightly embarrassed when the slide of the nude child was shown and that the embarrassment soon passed and fruitful discussions ensued. A typical comment was, "After the first explosion of giggles I told them that I knew that they were embarrassed but after a few days they would be used to using the words for body parts and seeing the pictures: When I asked them if they were interested in studying this subject, they were most interested."

Several teachers mentioned that students noticed the wider hips of the developed girls: "They noticed the wider hips of the older girls (in the pictures) as compared to the boys. 3102 offered the information that it was 'nature's' way of making women different so that there would be more room for a baby to grow inside the mother." This was then included in the revised materials.

Another typical comment from activity 2 was, "Most kids when they started wanted to use height and size of overall body to distinguish age. Happily as the lessons progressed the kids used other means such a pubic and breast development as a basis of age. They were further amazed to find out that at the same age there were different stages of development."

Figure 110 shows that teachers found student reactions to be extremely high across the three rating scales. All three activities were judged to be very important (see Figure 111).

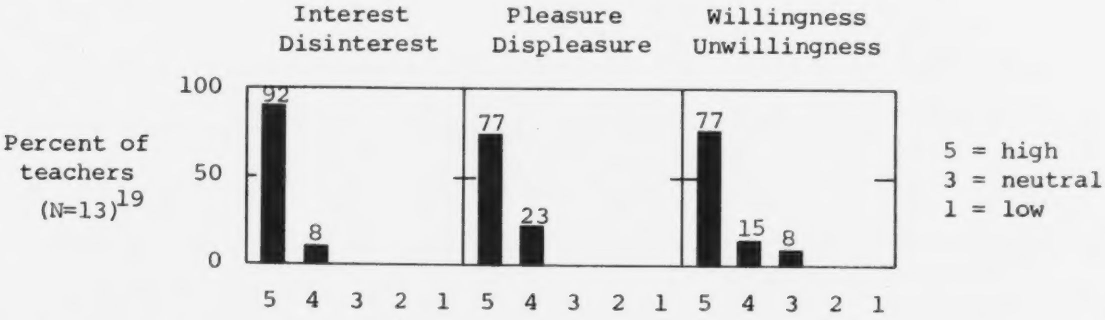


Figure 110. Reaction of the majority of students to activities 1 to 3

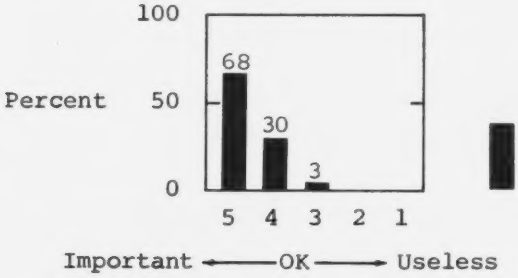


Figure 111. Importance to students of activities 1 to 3

Figure 112 shows the proportion of students in the class who were able to perform the behaviors specified by the five subobjectives.

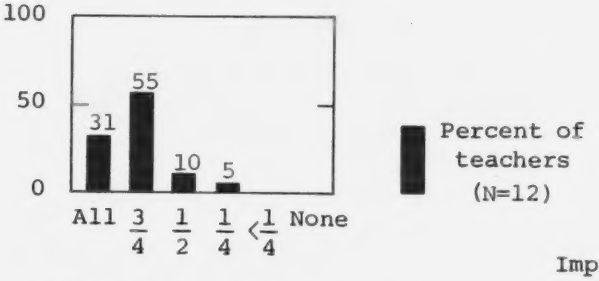


Figure 112. Proportion of students able to perform on subobjectives of objective 101

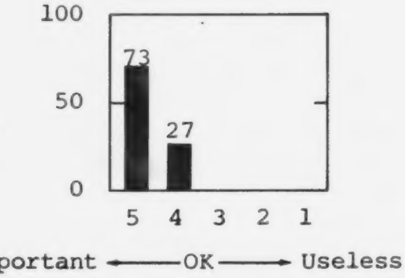


Figure 113. Importance of the subobjectives

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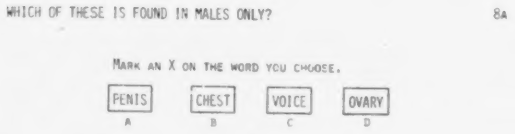
[19] The total number of teachers reporting in Unit IV is 13, although complete pretest and posttest data were obtained for only 10 teachers.

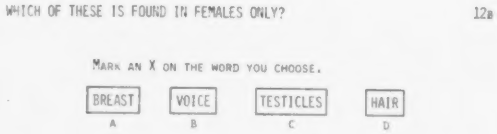
Eighty-six percent of the teachers reported that three-fourths or more of their students could successfully perform the desired behaviors. Teachers considered the subobjectives to be important also (see Figure 113).

Two item pairs were designed to assess achievement on this objective. Since no control group was used in Unit IV, only experimental group item data will be presented.


WHICH OF THESE IS FOUND IN MALES ONLY? 8A

MARK AN X ON THE WORD YOU CHOOSE.

PENIS A
CHEST B
VOICE C
OVARY D


WHICH OF THESE IS FOUND IN FEMALES ONLY? 12B

MARK AN X ON THE WORD YOU CHOOSE.

BREAST A
VOICE B
TESTICLES C
HAIR D

Item pair 8-A, 12-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest for the experimental group was 24 percent (from 39 to 63 percent). This gain is excellent and certainly attributable to the effect of instruction. Staff visits to classrooms at this time indicated a slight embarrassment on the part of some teachers to discuss male and female sex organs with their students during the early lessons. This effect gradually disappeared from the teachers as well as from the students, but we feel that the posttest achievement level would have been higher if teachers had begun using proper suggested terminology at the proper time. The biserial correlations are excellent, especially the .94 for posttest B.

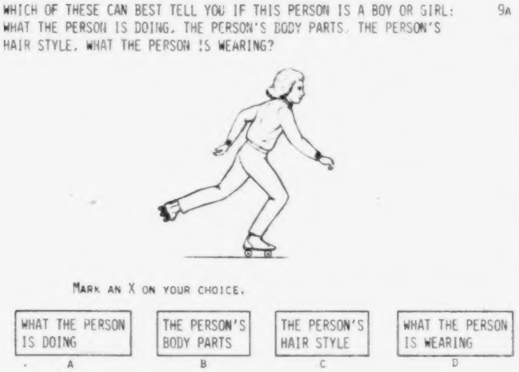
Table 229. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi- mental	8-A	47	40	28	17	15	0	0	59	64	5	3	27	0	0	.34	.37
	12-B	59	39	10	39	12	0	0	47	62	11	9	19	0	0	.23	.94

Table 230. Pretest to Posttest Changes
(The response choice for 8-A is cited first).

Item Pair 8-A, 12-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	D	B+D*	C	B	C+B	D	C	D+C
Experi-mental	+22	+23	+24	-23	+7	-8	-14	+1	-6	+12	-30	-9

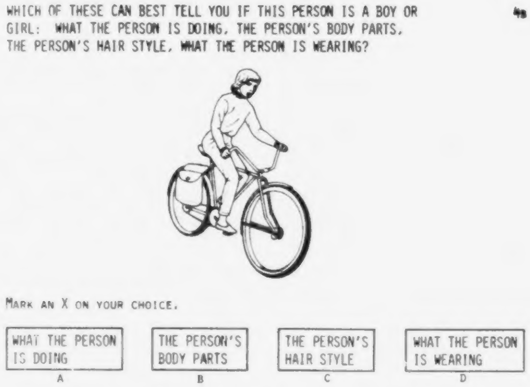
*B on Form A and D on Form B are not parallel distractors.



WHICH OF THESE CAN BEST TELL YOU IF THIS PERSON IS A BOY OR GIRL: WHAT THE PERSON IS DOING, THE PERSON'S BODY PARTS, THE PERSON'S HAIR STYLE, WHAT THE PERSON IS WEARING? 9A

MARK AN X ON YOUR CHOICE.

WHAT THE PERSON IS DOING	THE PERSON'S BODY PARTS	THE PERSON'S HAIR STYLE	WHAT THE PERSON IS WEARING
A	B	C	D



WHICH OF THESE CAN BEST TELL YOU IF THIS PERSON IS A BOY OR GIRL: WHAT THE PERSON IS DOING, THE PERSON'S BODY PARTS, THE PERSON'S HAIR STYLE, WHAT THE PERSON IS WEARING? 4B

MARK AN X ON YOUR CHOICE.

WHAT THE PERSON IS DOING	THE PERSON'S BODY PARTS	THE PERSON'S HAIR STYLE	WHAT THE PERSON IS WEARING
A	B	C	D

Item pair 9-A, 4-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was 16 percent (from 32 to 48 percent). Again, these gains are excellent, but probably would have been greater if teachers had commenced to use the proper terminology at the onset of instruction. This gain is attributed to the effect of instruction and can be accounted for by losses on all response choices except "what the person is doing," which has a mean total gain

Table 231. Item Responses and Biserial Correlations
for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	9-A	47	6	23	30	40	0	0	59	2	51	24	24	0	0	.40	.30
	4-B	59	2	39	32	27	0	0	47	9	45	21	26	0	0	.50	.66

Table 232. Pretest to Posttest Changes
(The response choice for 9-A is cited first.)

Item Pair 9-A, 4-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	C	C+C	D	D	D+D
Experimental	+28	+6	+16	-4	+7	+1	-6	-11	-8	-16	-1	-8

of one percent. Proper behavioral roles for males and females was emphasized and probably played a part in this result. Biserial correlations indicate that both items are good discriminators.

Objective 401. Students will identify and distinguish functional roles of organs related to sex. Four student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 4 to 7, 67 percent of the teachers reported that they used the strategies as described; 33 percent reported some modification. Some changes initiated by the teachers worked out very well: "For activity 5 I made a model using a plastic shampoo bottle for the uterus, etc. I used a flower seed instead of a bead and put about 3 drops of Elmer's glue in the oviduct to plant the 'egg' down the oviduct to the uterus and red colored water to wash the egg through the uterus and vagina. This was very effective. The plastic bottle that I used for the uterus had a neck about 4 inches long -- so I used three Tampax -- one at a time -- to show the children the 'process' of menstruation and the means used by girls to care for this function. The school nurse supplied me with a kit and we also demonstrated the use of sanitary pads. We repeated the demonstration several times so that the children could actually see the egg pass through and out of the 'organs'."

Some minor problems were encountered in activity 7 with the schematic diagram of the male reproductive system. The schematic diagram shows the testes above the penis and students were confusing the testes with the kidneys. Thus, in the revised materials, the urinary system was removed and tubes should be drawn from the testes to the penis.

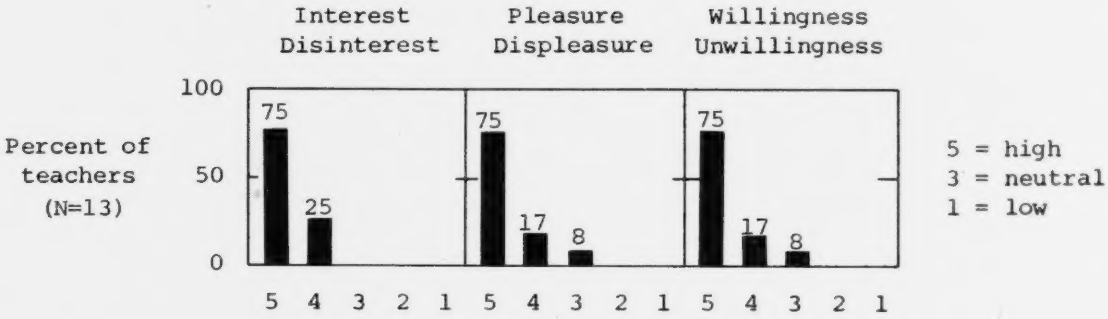


Figure 114. Reaction of the majority of students to activities 4 to 7

Figure 114 shows that teachers found student reactions very high across the three rating scales. The average importance ratings across the four activities were also very high (see Figure 115).

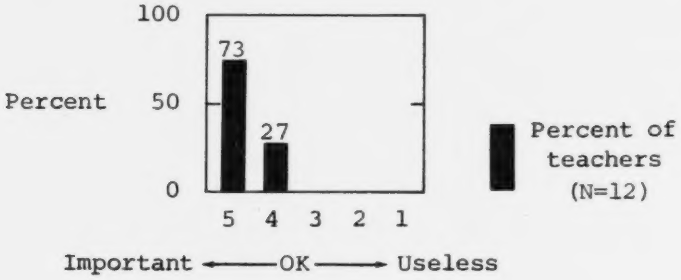


Figure 115. Importance to students of activities 4 to 7

Teachers reported a moderately high proportion of students experiencing success on the eight subobjectives of objective 401. Seventy-two percent of the teachers reported that three-fourths or more of their students were successful. Figure 117 shows that teachers rated the subobjectives as being very important for EMH students.

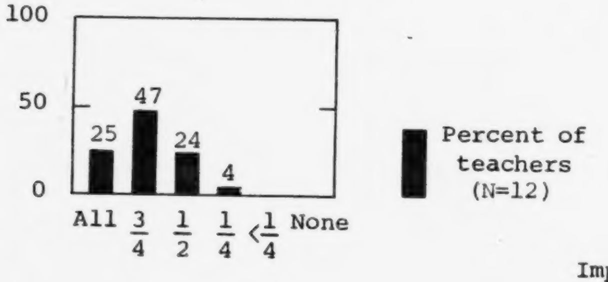


Figure 116. Proportion of students able to perform on subobjectives of objective 401

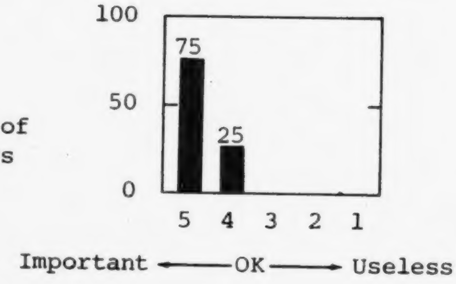
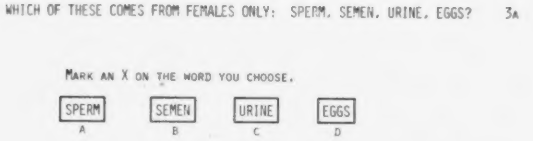


Figure 117. Importance of the subobjectives

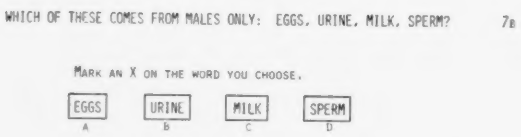
Five item pairs were designed to assess student achievement on objective 401.



WHICH OF THESE COMES FROM FEMALES ONLY: SPERM, SEMEN, URINE, EGGS? 3A

MARK AN X ON THE WORD YOU CHOOSE.

SPERM
A
SEMEN
B
URINE
C
EGGS
D



WHICH OF THESE COMES FROM MALES ONLY: EGGS, URINE, MILK, SPERM? 7B

MARK AN X ON THE WORD YOU CHOOSE.

EGGS
A
URINE
B
MILK
C
SPERM
D

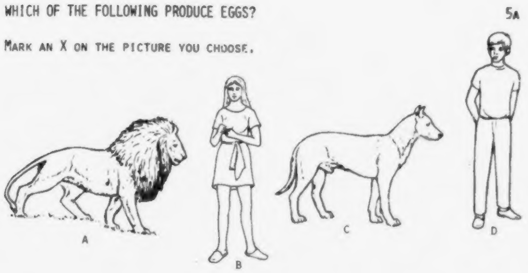
Item pair 3-A, 7-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was 35 percent (from 44 to 79 percent). This is considered an excellent gain attributable to the effect of instruction. Marked shifts occurred from all other item pairs from the pretest to posttest. Actually, pretest responses were very nearly random in pattern. Biserial correlations are excellent.

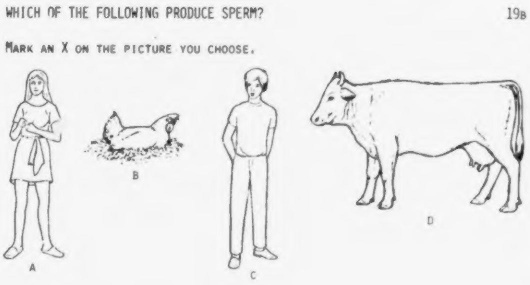
Table 233. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	3-A	47	28	19	21	32	0	0	59	7	0	3	90	0	0	.43	.80
	7-B	59	5	22	19	54	0	0	47	26	4	4	66	0	0	.56	.53

Table 234. Pretest to Posttest Changes
(The response choice for 3-A is cited first).

Item Pair 3-A, 7-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	D	D+D	A	A	A+A	C	B	C+B	B	C	B+C
Experi-mental	+58	+12	+35	-21	+21	0	-18	-18	-19	-19	-15	-17


WHICH OF THE FOLLOWING PRODUCE EGGS?
MARK AN X ON THE PICTURE YOU CHOOSE.
5A
A
B
C
D


WHICH OF THE FOLLOWING PRODUCE SPERM?
MARK AN X ON THE PICTURE YOU CHOOSE.
19B
A
B
C
D

Item pair 5-A, 19-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 37 percent (from 51 to 88 percent), which is considered excellent and is attributed to the effect of instruction. Very marked shifts occurred from all other response choices from pretest, where responses were very nearly random, to posttest. Biserial correlations are exceptionally high. It is apparent that before instruction many more students were familiar with the fact that males produced sperm than with the fact that human females

Table 235. Item Responses and Biserial Correlations
for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	5-A	47	38	38	15	6	2	0	59	0	97	2	2	0	0	.49	.75
	19-B	59	24	3	61	12	0	0	47	15	2	77	4	2	0	.44	.78

Table 236. Pretest to Posttest Changes
(The response choice for 5-A is cited first).

Item Pair 5-A, 19-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	B	A+B*	C	B	C+D*	D	A	D+A
Experi-mental	+59	+16	+37	-38	-1	-18	-13	-8	-10	-4	-9	-8

*A and C on Form A, and B and D on Form B are not parallel distractors.

produced eggs. The 97 percent posttest achievement level for Form A indicates that knowledge of female egg production is very near the mastery level.

MENSTRUATION IS: EMBARRASSING, SHAMEFUL, HARMFUL, NORMAL? 13A

MARK AN X ON YOUR CHOICE.

EMBARRASSING A SHAMEFUL B HARMFUL C NORMAL D

MENSTRUATION IS: SHAMEFUL, NORMAL, HARMFUL, EMBARRASSING? 18B

MARK AN X ON YOUR CHOICE.

SHAMEFUL A NORMAL B HARMFUL C EMBARRASSING D

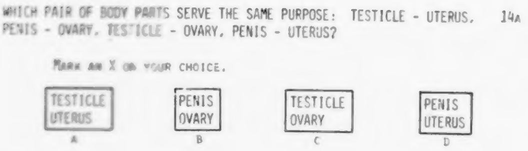
Item pair 13-A, 18-B is really a measure of student attitude. However, because we were striving to attain a shift from pretest to posttest for the response, "natural," we believe that students should receive credit for the desired response and the score for this item pair is included in the total score for both forms. Mean net gain from pretest to posttest was 24 percent (from 40 to 64 percent), which we consider to be excellent. If time were not such a factor near the closing of the school year, more instruction time could have resulted in a more significant shift in posttest responses. Biserial correlations are very good, although not entirely appropriate for an attitude question.

Table 237. Item Responses and Biserial Correlations
for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	13-A	47	26	23	13	38	0	0	59	15	8	12	61	3	0	.60	.67
	18-B	59	12	41	19	27	2	0	47	6	68	17	6	2	0	.50	.50

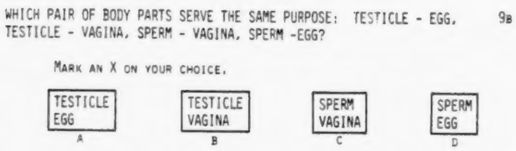
Table 238. Pretest to Posttest Changes
(The response choice for 13-A is cited first).

Item Pair 13-A, 18-B				Percent Change, Pretest to Posttest								
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	B	D+B	A	D	A+D	B	A	B+A	C	C	C+C
Experimental	+23	+27	+24	-11	-21	-16	-15	-6	-10	-21	-2	-11


WHICH PAIR OF BODY PARTS SERVE THE SAME PURPOSE: TESTICLE - UTERUS, PENIS - OVARY, TESTICLE - OVARY, PENIS - UTERUS? 14A

MARK AN X ON YOUR CHOICE.

TESTICLE UTERUS
A
PENIS OVARY
B
TESTICLE OVARY
C
PENIS UTERUS
D


WHICH PAIR OF BODY PARTS SERVE THE SAME PURPOSE: TESTICLE - EGG, TESTICLE - VAGINA, SPERM - VAGINA, SPERM -EGG? 9B

MARK AN X ON YOUR CHOICE.

TESTICLE EGG
A
TESTICLE VAGINA
B
SPERM VAGINA
C
SPERM EGG
D

Item pair 14-A, 9-B functions at the cognitive level of analysis. There was a mean net loss of four percent (from 36 to 32 percent) from pretest to posttest on this item pair. Both pretest and posttest response patterns were random. It is clear that the process of equating functions of two analogous organs is too complex for EMH students at this level. We recommend, however, that the item pair remain in the test for use by teachers during instruction to see if any students are capable of performing this complex task. Testing with this item should be on a one-to-one basis so the teacher can ask the student why a particular response was chosen. This is the only way to determine whether or not the student is guessing.

Table 239. Item Responses and Biserial Correlations
for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	14-A	47	17	17	26	40	0	0	59	3	22	24	51	0	0	.02	.31
	9-B	59	10	8	37	44	0	0	47	9	15	34	43	0	0	.40	.44

Table 240. Pretest to Posttest Changes
(The response choice for 14-A is cited first).

Item Pair 14-A, 9-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	D	C+D	A	A	A+A	B	B	B+B	D	C	D+C
Experi-mental	-2	-1	-4	-14	-1	-7	+5	+7	+7	+11	-3	+5

MASTURBATION IS: DESTRUCTIVE, SHAMEFUL, HARMFUL, NATURAL? 17A

MARK AN X ON YOUR CHOICE.

DESTRUCTIVE	SHAMEFUL	HARMFUL	NATURAL
A	B	C	D

MASTURBATION IS: NATURAL, SHAMEFUL, HARMFUL, DESTRUCTIVE? 14B

MARK AN X ON YOUR CHOICE.

NATURAL	SHAMEFUL	HARMFUL	DESTRUCTIVE
A	B	C	D

Item pair 17-A, 14-B was designed to measure changes in student attitude before and after instruction. This item pair is treated similar to 13-A, 18-B, that is, we are looking for a shift to the response, "natural," and this response is being scored and added to the total test score. Mean net gain from pretest to posttest was 29 percent (from 39 to 68 percent), which we attribute to the effect of instruction. There were losses on all other response choices.

Table 241. Item Responses and Biserial Correlations
for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	17-A	47	23	19	21	36	0	0	59	14	12	15	59	0	0	.62	.62
	14-B	59	41	20	25	14	0	0	47	79	2	6	13	0	0	.32	.78

Table 242. Pretest to Posttest Changes
(The response choice for 17-A is cited first).

Item Pair 17-A, 14-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	B	B+B	C	C	C+C
Experi-mental	+23	+38	+29	-9	-1	-4	-7	-18	-12	-6	-19	-12

Biserial correlations are exceptionally high, although not entirely appropriate for attitude questions.

Objective 402. *Students will infer social roles related to sex.* Two student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 8 and 9, 92 percent of the teachers reported that they used the strategies as described; eight percent reported some modification. No problems were encountered in either activity 8 or 9. One teacher's comment was typical of most received: "Activity 9 really turned the kids on. It was so good that the discussion could have been carried on almost forever. It was probably one of the best lessons for motivating my group."

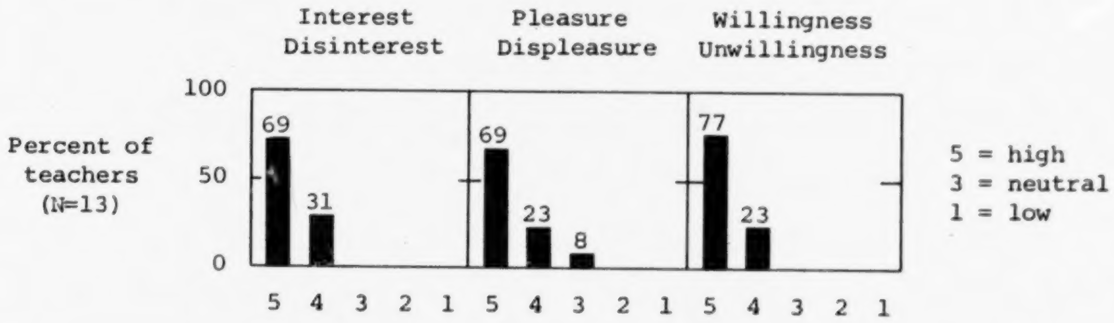


Figure 118. Reaction of the majority of students to activities 8 and 9

Figure 118 shows that student reactions were very high across the three rating scales. Both activities were judged important by the teachers, but the importance is not rated as high as student enthusiasm (see Figure 119).

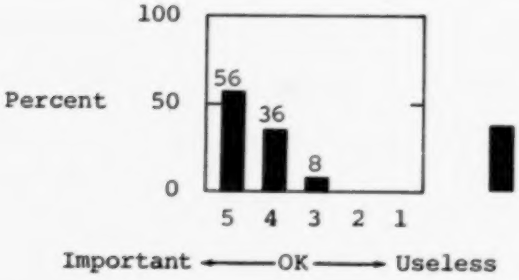


Figure 119. Importance to students of activities 8 and 9

Figure 120 shows the proportion of students who were able to successfully perform the behaviors specified by the two subobjectives of objective 402. Ninety-two percent of the teachers reported that three-fourths or more of their students were successful. Figure 121 shows that teachers rated the subobjectives as very important.

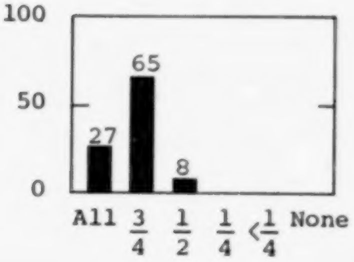


Figure 120. Proportion of students able to perform on subobjectives of objective 402

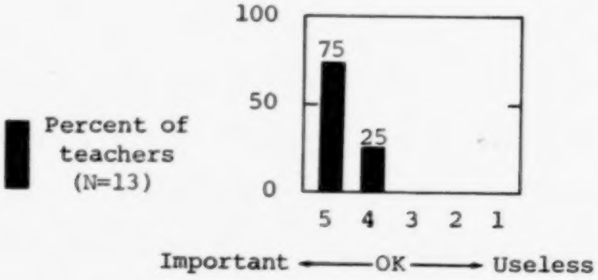


Figure 121. Importance of the subobjectives

No test items were designed to assess student achievement on this item. However, teacher reports, as indicated by the above figures, show that student success was at an acceptable level.

Objective 403. Students will associate parental roles with the formation and development of a new individual. Five student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activity 10, which deals with human fertilization, 82 percent of the teachers reported using the strategies as described, nine percent (one teacher) reported much modification. The teacher reporting much modification sent activities 10-15 home for the parents to teach; her feedback has been valuable and will continue to be used but we eliminated her class from the test analysis. No problems were encountered by the teachers in activity 10, only intense curiosity about sexual intercourse.

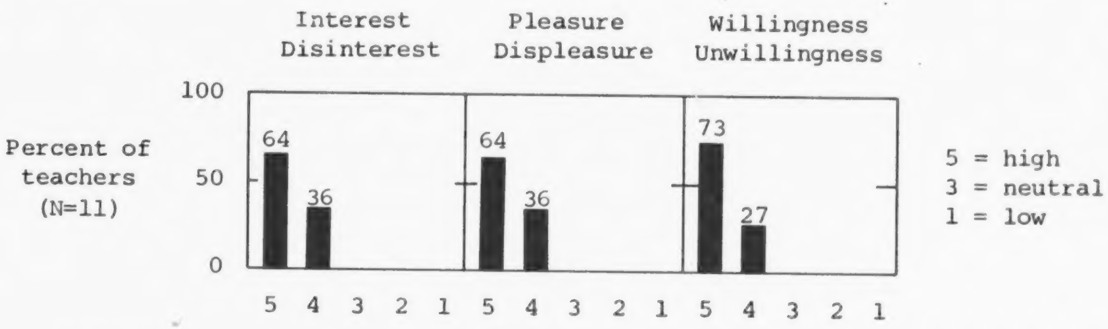


Figure 122. Reaction of the majority of students to activity 10

Figure 122 indicates that teachers judged student reactions to be very high across the three rating scales. Figure 123 shows that teachers considered the activity to very important.

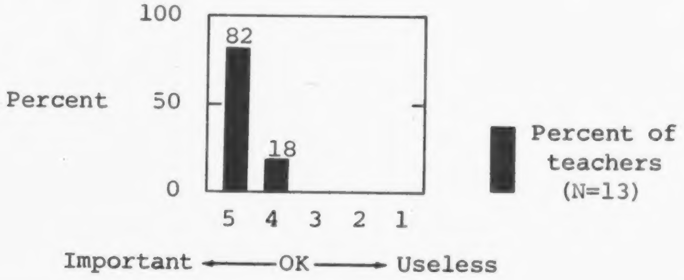


Figure 123. Importance to students of activity 10

Figure 124 shows the proportion of students who were able to successfully perform the behaviors specified by the seven subobjectives for activity 10. Eighty-four percent of the teachers reported that three-fourths or more of their students were successful. Figure 125 shows the average teacher rating of importance over the seven subobjectives.

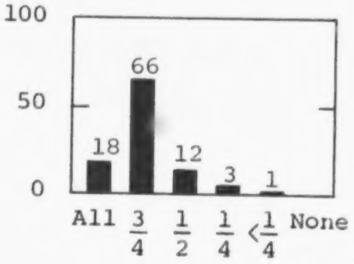


Figure 124. Proportion of students able to perform on subobjectives of activity 10

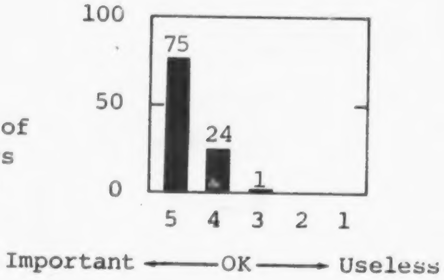


Figure 125. Importance of subobjectives

For activities 11 and 12, 83 percent of the teachers reported using the strategies as described; 17 percent reported some modification. All teachers reported that the strategies were successful. Teacher comments were very positive on these activities. An example is: "There were many great questions that this activity brought about such as why multiple births, birth control, and why some women did not get pregnant. It was a challenge to answer but great fun. Also I think it shows that the kids know more than we think. The lesson was really good and it made development very clear. I was pleased to find that the kids figured out that blood goes through the umbilical cord because blood carried food all over the body but the baby could not eat his own food so he had to use both mother's food and oxygen."

Figure 126 shows that student reactions were very high across the three rating scales. Figure 127 shows the average teacher rating of importance for the two activities.

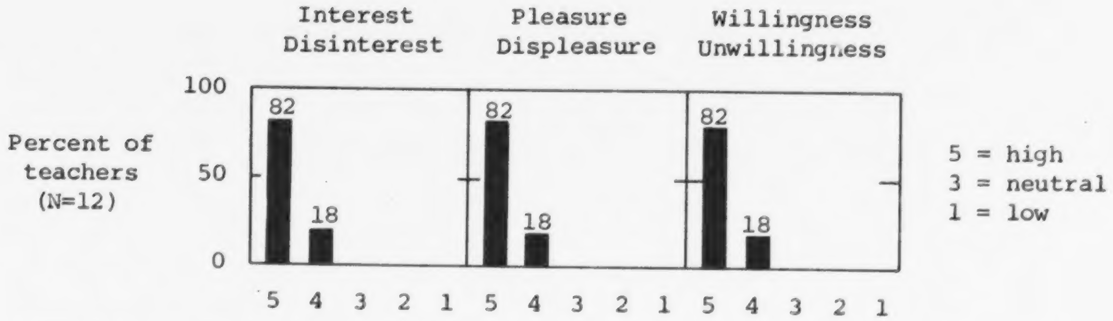


Figure 126. Reaction of the majority of students to activities 11 and 12.

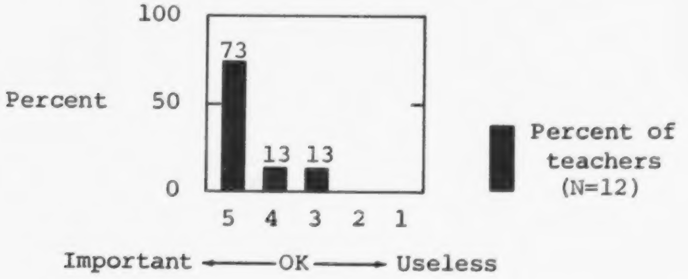


Figure 127. Importance to students of activities 11 and 12

Figure 128 shows the proportion of students who could successfully perform the behaviors specified by the seven subobjectives of activities 11 and 12. Ninety percent of the teachers reported that three-fourths or more of their students could perform the specified behaviors; 47 percent reported that all of their students were successful. Figure 129 shows the average teacher rating of the importance of the seven subobjectives.

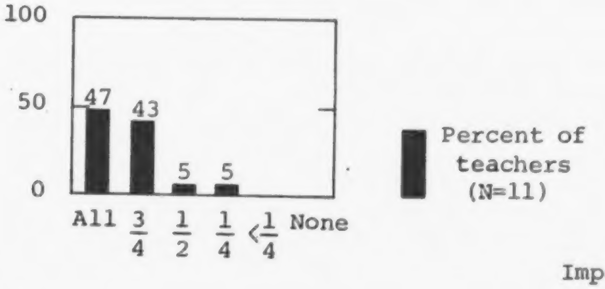


Figure 128. Proportion of students able to perform on subobjectives of objective 403

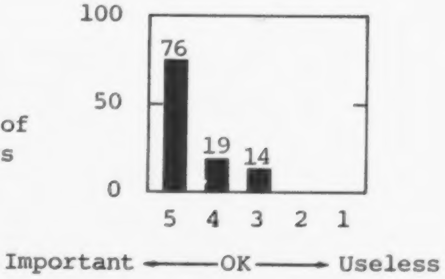


Figure 129. Importance of the subobjectives

For activities 13 and 14, 67 percent of the teachers reported that they used the strategies as described; 33 percent reported some modification. Ninety-two percent of the teachers reported that the strategies were successful. Many teachers reported student misconceptions concerning development of the unborn child and the actual birth process. One example is typical: "Most of the students thought the mother's 'stomach' was cut open to deliver a baby. Once the idea of regular birth delivery was presented they seemed to have no difficulty at all in following ideas. The girls really worried about what would happen to their stomach."

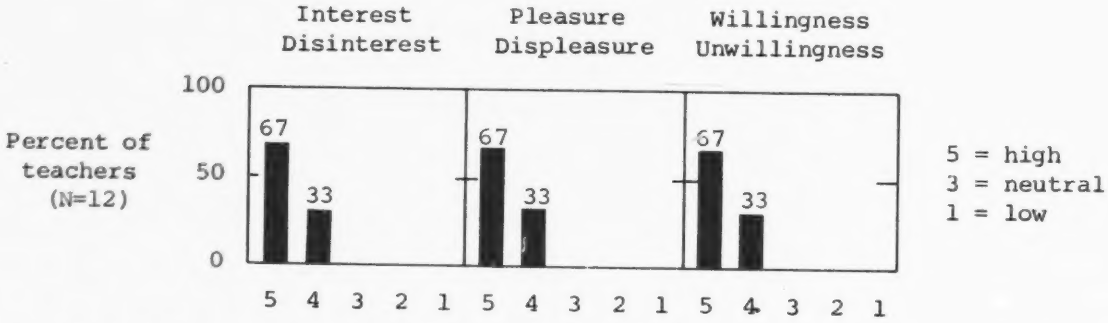


Figure 130. Reaction of the majority of students to activities 13 and 14

Figure 130 shows that student reactions were again very high across the three rating scales. Figure 131 shows that teachers also rated the activities as being very important for EMH children. One teacher is still embarrassed by the material and tends to rate most activities

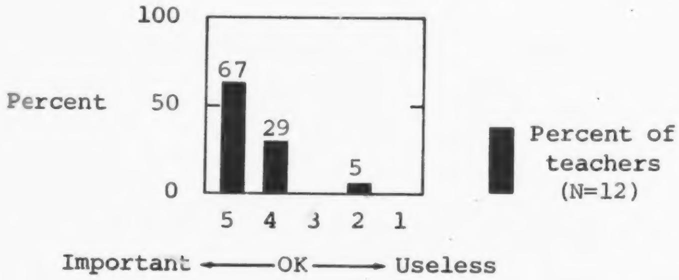


Figure 131. Importance to students of activities 13 and 14

dealing with reproductive organs or the reproductive process as unimportant.

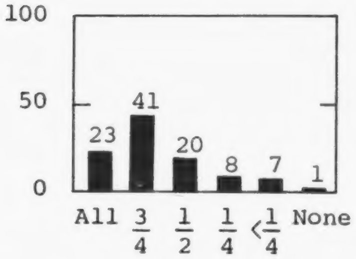


Figure 132. Proportion of students able to perform on subobjectives of activities 13 and 14

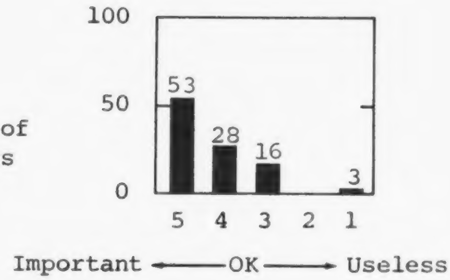


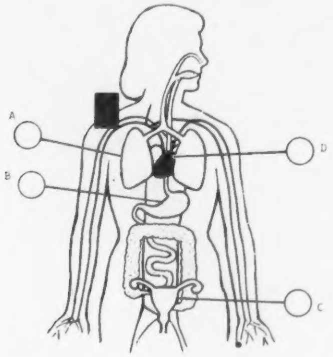
Figure 133. Importance of the subobjectives

Figure 132 shows that the success ratio averaged across the seven subobjectives of activities 13 and 14 was lower than for most previous activities. Those subobjectives where student success was low dealt mostly with determining the date of birth and date of conception by counting days on the calendar. These activities should be simplified and clarified in the revised materials. Several teachers noted that having children determine the date on which they were conceived could lead to problems or embarrassment for the child, but the majority of teachers advised us to leave this in the activity and the discretion of the teacher would determine whether or not it was used. The importance of the subobjectives was generally quite high. The average ratings across the seven subobjectives are shown in Figure 133. The above problem led to a decreased rating by several teachers for several objectives.

Eight item pairs were designed to measure student achievement on objective 403.

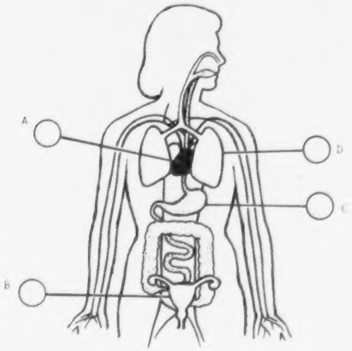
WHERE DOES A BABY DEVELOP? 4A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHERE DOES A BABY DEVELOP? 6B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



Item pair 4-A, 6-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 35 percent (from 60 to 95 percent), which we feel is spectacular and most certainly attributable to the effect of instruction. The most notable shift from pretest to posttest was from choosing the stomach as the location where the baby develops to choosing the uterus. The 95 percent posttest level approaches the level of mastery for this concept.

Table 243. Item Responses and Biserial Correlations for Experimental Group

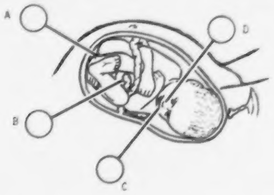
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi- mental	4-A	47	0	45	55	0	0	0	59	0	3	95	2	0	0	.32	.95
	6-B	59	0	64	25	3	7	0	47	0	96	4	0	0	0	.62	.45

Table 244. Pretest to Posttest Changes (The response choice for 4-A is cited first).

Item Pair 4-A, 6-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	D	A+D	B	C	B+C	D	A	D+A
Experi- mental	+40	+32	+35	0	-3	-2	-42	-21	-31	+2	0	+1

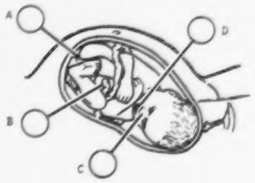
BEFORE BIRTH WHERE DOES FOOD, OXYGEN, AND WATER ENTER THE BABY? 7A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



BEFORE BIRTH WHERE DO WASTES LEAVE THE BABY? 3B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



Item pair 7-A, 3-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 39 percent (from 37 to 76 percent). This excellent gain is attributed to the effect of instruction and can be accounted for by losses on all other response choices. The most notable shift was from choosing the anus and mouth or nose as the sites of entering essentials and exiting waste materials (which were studied in previous units) to choosing the umbilical cord on the posttest. Biserial correlations are unusually high.

Table 245. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	7-A	47	6	34	43	17	0	0	59	3	86	7	3	0	0	.53	.64
	3-B	59	47	39	5	8	0	0	47	26	64	0	6	4	0	.53	.84

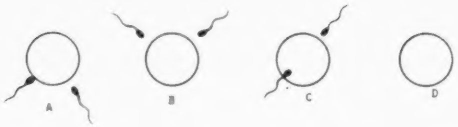
Table 246. Pretest to Posttest Changes (The response choice for 7-A is cited first).

Item Pair 7-A, 3-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	B	B+B	A	A	A+A	C	D	C+D	D	C	D+C
Experi-mental	+52	+25	+39	-3	-21	-16	-36	-2	-17	-14	-5	-8

WHICH DRAWING SHOWS A FERTILIZED EGG?

MARK AN X ON YOUR CHOICE.

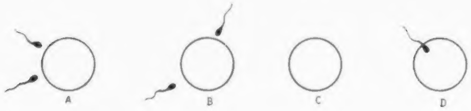
10A



WHICH DRAWING SHOWS A FERTILIZED EGG?

MARK AN X ON YOUR CHOICE.

13B



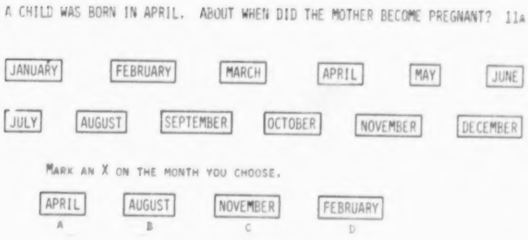
Item pair 10-A, 13-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 27 percent (from 31 to 58 percent). We attribute this excellent gain to the effect of instruction. One possible problem on this item pair is that any of the eggs could already have been fertilized, except the one which is being fertilized (response choice C on Form A and D on Form B). It is recommended that the stem of this item be changed to "Which egg is being fertilized," to eliminate a possible problem of interpretation. Biserial correlation levels are good, indicating that the item pair is discriminating between high and low-scoring students.

Table 247. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	10-A	47	2	4	32	62	0	0	59	5	3	54	37	0	0	.47	.39
	13-B	59	10	8	49	31	2	0	47	2	9	28	62	0	0	.47	.33

Table 248. Pretest to Posttest Changes (The response choice for 10-A is cited first).

Item Pair 10-A, 13-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	D	C+D	A	B	A+B	B	A	B+A	D	C	D+C
Experimental	+22	+31	+27	+3	-1	+2	-1	-8	-4	-25	-21	-22



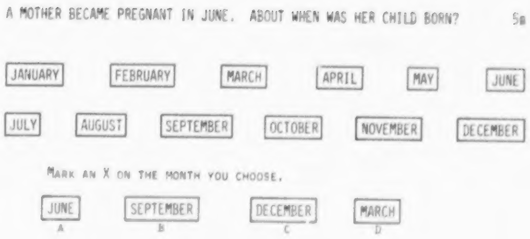
A CHILD WAS BORN IN APRIL. ABOUT WHEN DID THE MOTHER BECOME PREGNANT? 11A

JANUARY FEBRUARY MARCH APRIL MAY JUNE

JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

MARK AN X ON THE MONTH YOU CHOOSE.

APRIL	AUGUST	NOVEMBER	FEBRUARY
A	B	C	D



A MOTHER BECAME PREGNANT IN JUNE. ABOUT WHEN WAS HER CHILD BORN? 5B

JANUARY FEBRUARY MARCH APRIL MAY JUNE

JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

MARK AN X ON THE MONTH YOU CHOOSE.

JUNE	SEPTEMBER	DECEMBER	MARCH
A	B	C	D

Item pair 11-A, 5-B functions at the cognitive level of comprehension. Item 11-A was deleted from analysis because there was no correct choice (July) for the item. Because of this, no average gains were computed and only achievement levels and gains for item 5-B are shown. Mean gain from pretest to posttest for 5-B was 40 percent (from 20 to 60 percent), indicating that instruction did have an effect on posttest achievement. Biserial correlations are average.

Table 249. Item Responses and Biserial Correlations for Experimental Group

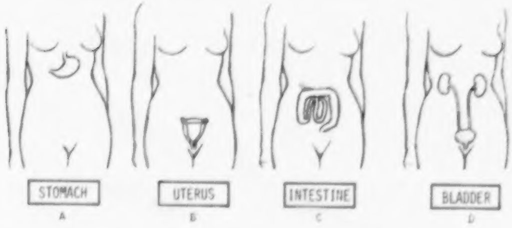
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	11-A	47	deleted							deleted							
	5-B	59	12	29	31	20	8	0	47	4	15	9	60	13	0	.46	.37

Table 250. Pretest to Posttest Changes

Item Pair 11-A, 5-B	Percent Change, Pretest to Posttest			
Student Group	Correct Choice	Parallel Distractor Pairs		
	D	A	B	C
Experi-mental	+40	-8	-14	-22

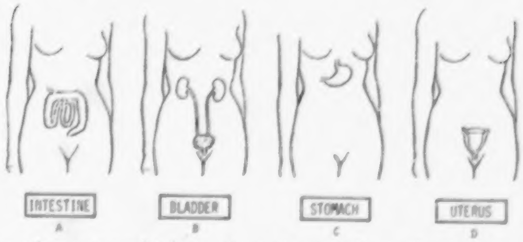
BEFORE THEY ARE BORN BABIES GROW IN THEIR MOTHER'S: 12A
STOMACH, UTERUS, INTESTINE, BLADDER?

MARK AN X ON YOUR CHOICE.



BEFORE THEY ARE BORN BABIES GROW IN THEIR MOTHER'S: 16B
INTESTINE, BLADDER, STOMACH, UTERUS?

MARK AN X ON YOUR CHOICE.



Item pair 12-A, 16-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was 52 percent (from 36 to 88 percent), a truly remarkable gain attributable to the effect of instruction. The most notable change, as was the case with item pair 4-A, 6-B was from choosing the stomach on the pretest to choosing the uterus on the posttest as the site where the unborn baby develops. Biserial correlations are exceptionally high.

Table 251. Item Responses and Biserial Correlations for Experimental Group

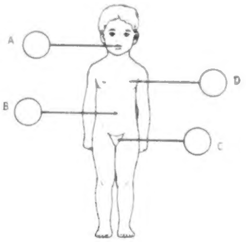
Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	12-A	47	57	17	11	15	0	0	59	5	88	3	3	0	0	.66	.84
	16-B	59	5	5	37	51	2	0	47	2	4	4	89	0	0	.40	.79

Table 252. Pretest to Posttest Changes (The response choice for 12-A is cited first).

Item Pair 12-A, 16-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	D	B+D	A	C	A+C	C	A	C+A	D	B	D+B
Experi-mental	+71	+38	+52	-52	-33	-41	-8	-3	-5	-12	-1	-6

WHERE WAS THE UMBILICAL CORD ONCE ATTACHED?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

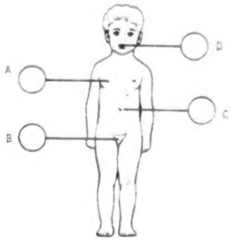


15A

WHERE WAS THE UMBILICAL CORD ONCE ATTACHED?

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.

8B



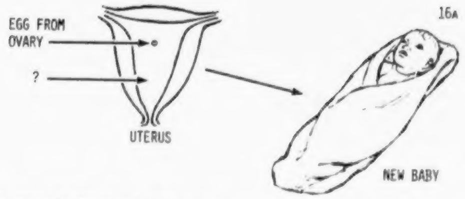
Item pair 15-A, 8-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 15 percent (from 74 to 89 percent). This item pair is judged to provide baseline information, since 74 percent of the students in our sample knew that the umbilical cord was attached at the navel prior to instruction. With this high pretest level, the 15 percent gain is excellent and is attributed to the effect of instruction. Biserial correlations are exceptionally high.

Table 253. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	15-A	47	0	62	17	21	0	0	59	0	90	8	2	0	0	.63	.86
	8-B	59	0	14	83	3	0	0	47	0	13	87	0	0	0	.45	.81

Table 254. Pretest to Posttest Changes
(The response choice for 15-A is cited first.)

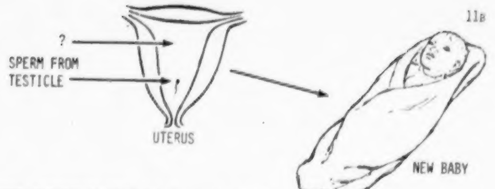
Item Pair 15-A, 8-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	C	B+C	A	D	A+D	C	B	C+B	D	A	D+A
Experi-mental	+28	+4	+15	0	-3	-2	-9	-1	-5	-19	0	-8



WHAT IS MISSING FROM THE DIAGRAM ABOVE?

MARK AN X ON YOUR CHOICE.

EGG	SPERM	PENIS	EGG TUBE
A	B	C	D



WHAT IS MISSING FROM THE DIAGRAM ABOVE?

MARK AN X ON YOUR CHOICE.

EGG	SPERM	PENIS	EGG TUBE
A	B	C	D

Item pair 16-A, 11-B functions at the cognitive level of analysis. Mean net gain from pretest to posttest was 41 percent (from 15 to 56 percent), which is exceptionally high and attributable to the effect of instruction. This item demonstrates clearly that many EMH students can handle problems involving high level cognitive processes involving one variable. The comparison of two variables at this same cognitive level was not successful (see item pair 14-A, 9-B, objective 401). Biserial correlations indicate that both items are good discriminators.

Table 255. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	16-A	47	17	15	34	28	6	0	59	7	58	8	24	3	0	.62	.52
	11-B	59	15	24	34	25	2	0	47	53	9	15	23	0	0	.57	.42

Table 256. Pretest to Posttest Changes
(The response choice for 16-A is cited first.)

Item Pair 16-A, 11-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	A	B+A	A	B	A+B	C	C	C+C	D	D	D+D
Experi-mental	+43	+38	+41	-10	-15	-13	-26	-19	-23	-4	-2	-2

IF AN EGG IS FERTILIZED, THE FEMALE CAN EXPECT TO: HAVE A BABY, BECOME ILL, HAVE A MENSTRUAL PERIOD, LOSE A BABY? 18A

MARK AN X ON YOUR CHOICE.

A	B	C	D
HAVE A BABY	BECOME ILL	HAVE A MENSTRUAL PERIOD	LOSE A BABY

IF AN EGG IS NOT FERTILIZED, THE FEMALE CAN EXPECT TO: HAVE A BABY, BECOME ILL, HAVE A MENSTRUAL PERIOD, LOSE A BABY? 15B

MARK AN X ON YOUR CHOICE.

A	B	C	D
HAVE A BABY	BECOME ILL	HAVE A MENSTRUAL PERIOD	LOSE A BABY

Item pair 18-A, 15-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was 30 percent (from 33 to 63 percent). This very good gain is attributed to the effect of instruction. If more time could have been spent on instruction in Unit IV we feel that the posttest achievement level would have been higher. Biserial correlations are excellent.

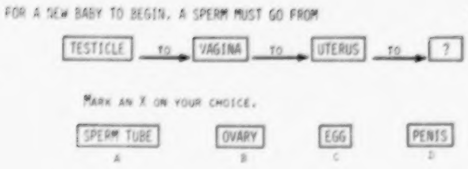
Table 257. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	18-A	47	49	9	13	30	0	0	59	73	5	10	12	0	0	.56	.60
	15-B	59	5	10	20	64	0	0	47	9	2	51	38	0	0	.19	.73

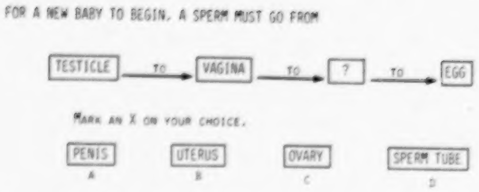
Table 258. Pretest to Posttest Changes
(The response choice for 18-A is cited first.)

Item Pair 18-A, 15-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	C	A+C	B	B	B+B	C	A	C+A	D	D	D+D
Experi-mental	+24	+31	+30	-4	-8	-6	-3	+4	+1	-18	-26	-25

Item pair 20-A, 17-B functions at the cognitive level of comprehension. Mean net gain from pretest to posttest was 26 percent (from 18 to 44 percent). This is an entirely acceptable level of achievement which we attribute to the effect of instruction. Posttest achievement


FOR A NEW BABY TO BEGIN, A SPERM MUST GO FROM
TESTICLE
TO
VAGINA
TO
UTERUS
TO
?
MARK AN X ON YOUR CHOICE.
SPERM TUBE
A
OVARY
B
EGG
C
PENIS
D

20A


FOR A NEW BABY TO BEGIN, A SPERM MUST GO FROM
TESTICLE
TO
VAGINA
TO
?
TO
EGG
MARK AN X ON YOUR CHOICE.
PENIS
A
UTERUS
B
OVARY
C
SPERM TUBE
D

17B

level was not as high as on item pair 16-A, 11-B, where a visual clue was given in addition to the word clue. Biserial correlation levels are average.

Table 259. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	20-A	47	17	19	19	32	13	0	59	10	37	42	7	3	0	.39	.34
	17-B	59	20	17	25	34	3	0	47	9	47	26	13	7	0	.28	.34

Table 260. Pretest to Posttest Changes (The response choice for 20-A is cited first.)

Item Pair 20-A, 17-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	B	C+B	A	D	A+D	B	C	B+C	D	A	D+A
Experimental	+23	+30	+26	-7	-21	-14	+18	+1	+10	-25	-11	-17

Objective 404. Students will relate changes in life's continuum to human growth and development. Six student activities and other instructional strategies were designed to develop student competencies to achieve this objective.

For activities 15 to 17, 50 percent of the teachers reported using the strategies as described; 29 percent reported some modification; and

14 percent reported much modification. Seventy-nine percent of the teachers reported that the strategies were successful and 21 percent reported some difficulties. The major complaint received concerned the colors used on the daylight blackboard projection slides with most students desiring more realistic colors. The other problem was the difficulty in finding a mother willing to bring an infant into the classroom for a discussion of the proper care of the newborn. Also, the slide projected on the wall to measure height would not work in several classrooms where the projector could not be moved far enough away from the wall to project an image of the proper size. Most difficulties were overcome by teacher ingenuity or by telephone calls to the BSCS project staff.

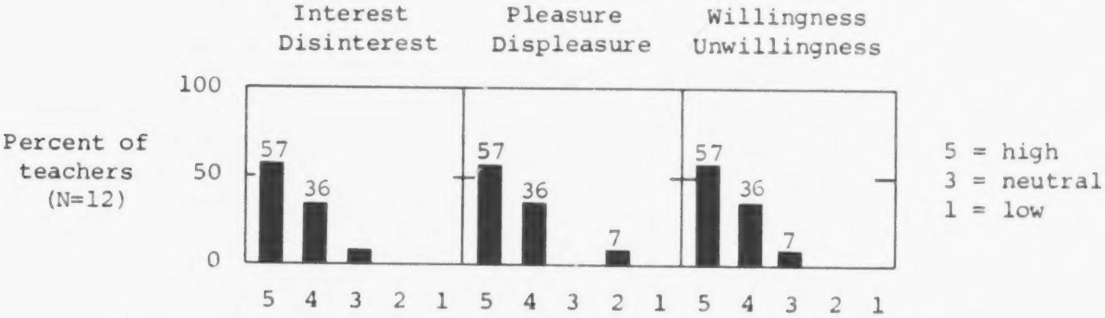


Figure 134. Reaction of the majority of students to activities 15 to 17

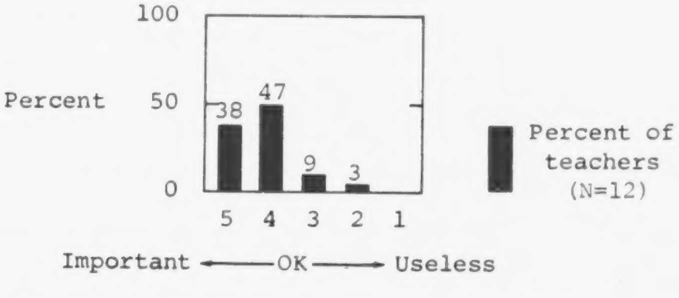


Figure 135. Importance to students of activities 15 to 17

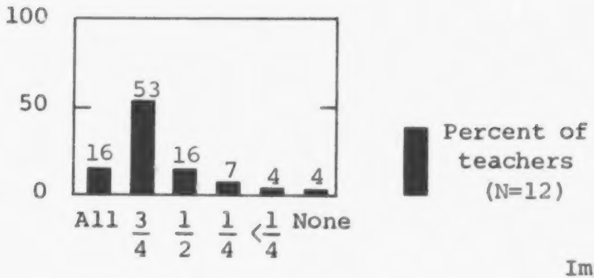


Figure 136. Proportion of students able to perform on subobjectives of activities 15 to 17

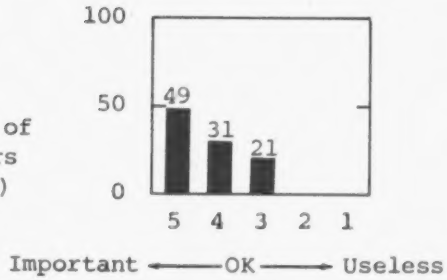


Figure 137. Importance of the subobjectives

Figure 134 shows that teachers rated student responses as positive across the three rating scales. Figure 135 shows the average rating of importance across the three activities. Activity 17 received the lowest rating because some teachers felt that the graphing of weight and height in Unit I was sufficient and this type of exercise need not be repeated.

Figure 136 shows that student success on the subobjectives, as estimated by teachers, was not as high for these three activities as for previous ones. The main problem centered around the graphing activities in activity 17. Figure 137 shows that teachers rated the importance of the subobjectives on the positive side of the scale.

For activities 18 to 20, 61 percent of the teachers reported using the strategies as described; 39 percent reported some modification. Ninety-two percent reported that the strategies were successful and eight percent (one teacher) reported some difficulties. In general, most comments were very positive, such as, "Activity 18 was great because kids got practice in measuring and reasoning. People who say these kids cannot reason should see the results of a lesson like this. We had to work a little harder with some of them but eventually through reason they did make accurate judgments."

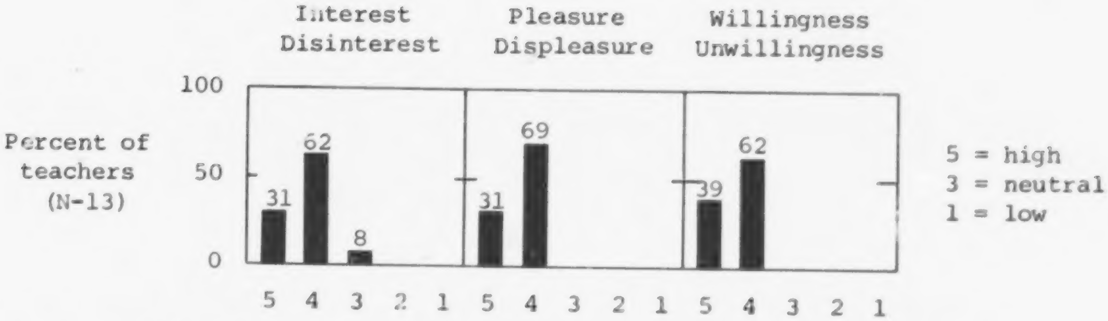


Figure 138. Reaction of the majority of students to activities 18 to 21

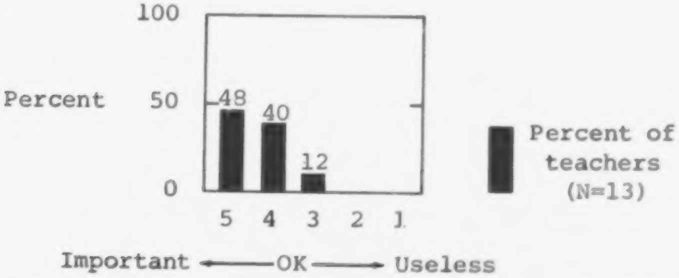


Figure 139. Importance to students of activities 18 to 20

Concerning activity 19, a typical comment was, "Activity 19 was one of the highest motivational lessons we have had when the kids had to interpret the slides. All of them were busting to talk about them. The humor was the factor, I believe, that really turned the kids on."

Figure 138 shows the teachers' rating of student reactions to be very high across the three rating scales. Ratings for activity 21 are included here because they could not be separated. Figure 139 shows that the overall average rating of importance for activities 18 to 20 was high.

Figure 140 shows that the proportion of students able to successfully perform the behaviors specified by the subobjectives of activities 18 to 20 was high, but not as high as for some previous activities. Sixty-eight percent of the teachers estimated that three-fourths or more of their students were successful. Figure 141 shows that teachers considered the subobjectives to be important.

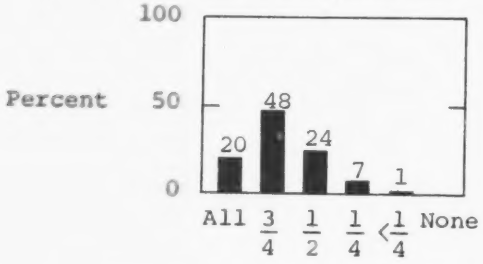


Figure 140. Proportion of students able to perform on subobjectives of activities 18 to 20

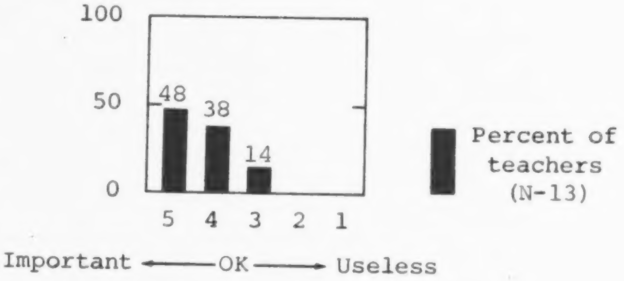
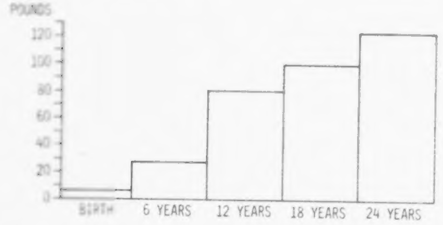


Figure 141. Importance of the subobjectives

Two item pairs were designed to assess student achievement on objective 404.

LOOK AT THE GRAPH OF JUDY'S WEIGHT. 6A

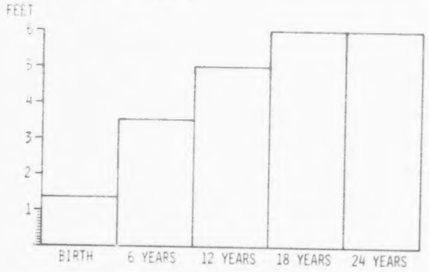


WHEN DID SHE GROW THE MOST: BETWEEN BIRTH AND 6 YEARS, BETWEEN 6 AND 12 YEARS, BETWEEN 12 AND 18 YEARS, BETWEEN 18 AND 24 YEARS?

MARK AN X ON THE PERIOD OF MOST GROWTH.

BETWEEN BIRTH AND 6 YEARS A
BETWEEN 6 AND 12 YEARS B
BETWEEN 12 AND 18 YEARS C
BETWEEN 18 AND 24 YEARS D

LOOK AT THE GRAPH OF JACK'S HEIGHT. 2B



WHEN DID HE GROW THE MOST: BETWEEN BIRTH AND 6 YEARS, BETWEEN 6 AND 12 YEARS, BETWEEN 12 AND 18 YEARS, BETWEEN 18 AND 24 YEARS?

MARK AN X ON THE PERIOD OF MOST GROWTH.

BETWEEN BIRTH AND 6 YEARS A
BETWEEN 6 AND 12 YEARS B
BETWEEN 12 AND 18 YEARS C
BETWEEN 18 AND 24 YEARS D

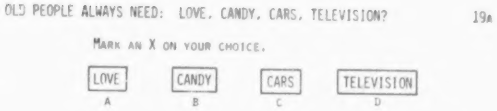
Item pair 6-A, 2-B functions at the cognitive level of analysis. Mean net gain from pretest to posttest was 20 percent (from 7 to 27 percent), but the posttest achievement level was still low. Most teachers recommended using two different types of shading and alternating these in the bars on the graph to aid in visual discrimination. In spite of the high difficulty level, we believe that shading will increase success and that this item pair could be a valuable diagnostic tool for teachers.

Table 261. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi-mental	6-A	47	13	6	13	43	26	0	59	29	27	12	25	7	0	.60	.38
	2-B	59	7	14	20	54	5	0	47	28	19	11	32	11	0	.15	.24

Table 262. Pretest to Posttest Changes
(The response choice for 6-A is cited first.)

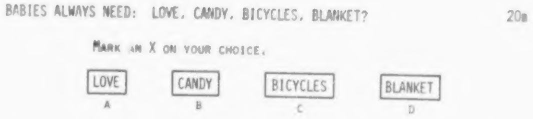
Item Pair 6-A, 2-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	B	A	B+A	A	B	A+B	C	C	C+C	D	D	D+D
Experi-mental	+21	+21	+20	+16	+5	+11	-1	-9	-5	-18	-22	-21



OLD PEOPLE ALWAYS NEED: LOVE, CANDY, CARS, TELEVISION? 19A

MARK AN X ON YOUR CHOICE.

LOVE A CANDY B CARS C TELEVISION D



BABIES ALWAYS NEED: LOVE, CANDY, BICYCLES, BLANKET? 20B

MARK AN X ON YOUR CHOICE.

LOVE A CANDY B BICYCLES C BLANKET D

Item pair 19-A, 20-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was 15 percent (from 72 to 87 percent) indicating that this item also provides baseline information. The most notable shift was from choosing television and blanket to love. Considering the relatively high pretest level, the posttest level is very good and we attribute this gain to the effect of instruction. The biserial correlations are excellent.

Table 263. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
		N	Percent of N						N	Percent of N						Pre	Post
			A	B	C	D	M	O		A	B	C	D	M	O		
Experimental	19-A	47	74	6	9	11	0	0	59	86	2	7	5	0	0	.55	.59
	20-B	59	71	3	3	22	0	0	47	89	2	0	9	0	0	.50	.73

Table 264. Pretest to Posttest Changes (The response choice for 19-A is cited first.)

Item Pair 19-A, 20-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	A	A	A+A	B	B	B+B	C	C	C+C	D	D	D+D
Experimental	+12	+18	+15	-4	-1	-2	-2	-3	-2	-6	-13	-10

Objective 405. Students will account for the phenomena that have contributed to the development of *ME NOW*. One student activity and other instructional strategies were designed to develop student competencies to achieve this objective.

All teachers reported using the strategies as described and reported that they were successful. No figure is reported here for teachers' assessment of student reaction because it was contained with activities 18 to 20 and was impossible to separate. Comments from teachers on activity 21 and on the whole program were very positive and complimentary. One example is, "I was happy to find that there was little trouble getting across what a trait is. I did this by saying all things that make you are traits. Also the kids did a great job distinguishing inherited traits from learned traits. They did so much faster and with much more ease than I thought they would.

"I had one girl who could not taste P.T.C. paper when all her family could. She was kind of shook until the grandparent explanation was given to her. I also had one boy who had a sister who could not taste it while others could. This was a good lesson to reinforce the idea of inherited traits.

"Final comment -- This entire program was sensational from start to finish. It was a joy to this teacher and tremendously accepted by all of my students. Thank you from all of us."

Figure 142 shows that teachers considered activity 21 to be very important.

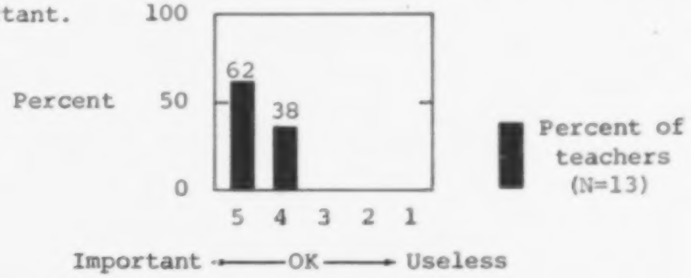


Figure 142. Importance to students of activity 21

Figure 143 shows that the teachers' estimate of students ability to perform the behaviors specified by the subobjectives of activity 21 was high. Eighty-five percent of the teachers reported that three-fourths or more of their students were successful. Figure 144 shows that teachers considered the subobjectives to be important to EMH students.

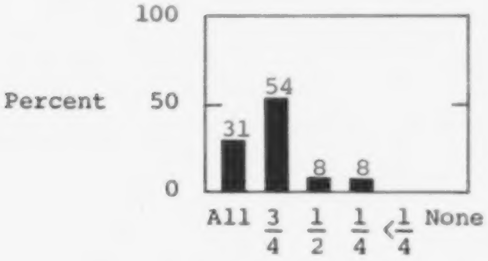


Figure 143. Proportion of students able to perform on subobjectives of objective 405

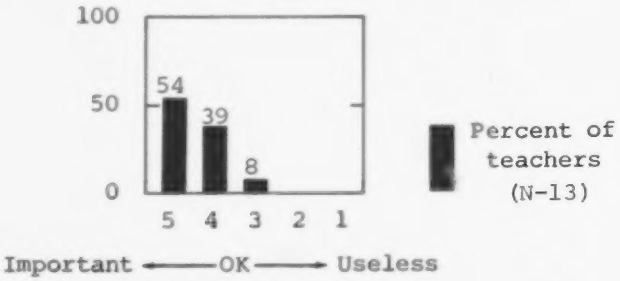
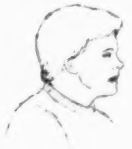


Figure 144. Importance of the subobjectives

One item pair was designed to assess student achievement on objective 405.

LOOK AT THE PICTURE OF THE BOY. WHICH OF THESE WAS NOT INHERITED FROM HIS PARENTS: MOUTH, EYE COLOR, HAIR STYLE, NOSE?

1A

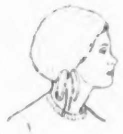


MARK AN X ON THE CHARACTERISTIC YOU CHOOSE.

A ☐ MOUTH B ☐ EYE COLOR C ☐ HAIR STYLE D ☐ NOSE

LOOK AT THE PICTURE OF THE GIRL. WHICH OF THESE WAS NOT INHERITED FROM HER PARENTS: HAIR STYLE, EYE COLOR, MOUTH, NOSE?

10B



MARK AN X ON THE CHARACTERISTIC YOU CHOOSE.

☐ HAIR STYLE A ☐ EYE COLOR B ☐ MOUTH C ☐ NOSE D

Item pair 1-A, 10-B functions at the cognitive level of knowledge. Mean net gain from pretest to posttest was only one percent (from 68 to 69 percent). Comments from most teachers indicated that they were very rushed during the final days of school to finish *ME NOW* and administer posttests and, unfortunately, this last activity did not really receive the attention it deserves. We are confident that the posttest level of success would improve with the proper presentation of the materials.

Table 265. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experi- mental	1-A	47	17	11	66	6	0	0	59	15	7	61	17	0	0	.06	.49
	10-B	59	69	19	7	5	0	0	47	79	6	11	4	0	0	.66	.18

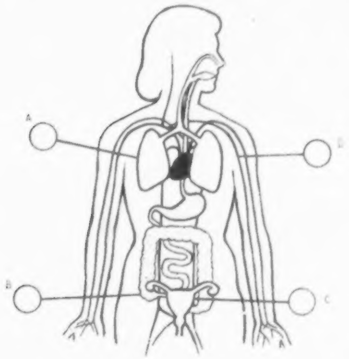
Table 266. Pretest to Posttest Changes (The response choice for 1-A is cited first.)

Item Pair 1-A, 10-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	C	A	C+A	B	B	B+B	A	C	A+C	D	D	D+D
Experi- mental	-5	+10	+1	-4	-13	-8	-2	+4	-2	+11	-1	+6

One item pair was included to measure concepts learned in Unit II.

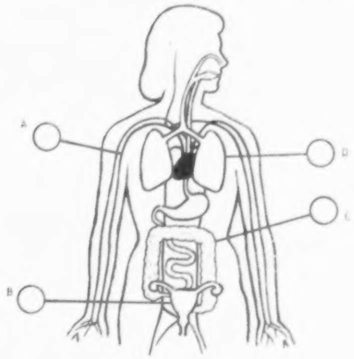
WHAT PART CARRIES OXYGEN TO ALL PARTS OF THE BODY? 2A

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



WHAT PART CARRIES FOOD TO ALL PARTS OF THE BODY? 1B

MARK AN X IN THE CIRCLE ON THE LINE THAT TOUCHES THAT PART.



Item pair 2-A, 1-B functions at the cognitive level of comprehension. The pretest and posttest levels of 39 and 44 percent are somewhat lower than expected. A careful examination of the items indicates that proper interpretation hinges on the word "carries." A large number of students, especially in Form A (64 and 61 percent) are choosing the lung. We interpret this result as a problem with the item and not with student memory.

Table 267. Item Responses and Biserial Correlations for Experimental Group

Student Group	Item #	Pretest							Posttest							r_b	
			Percent of N							Percent of N							
		N	A	B	C	D	M	O	N	A	B	C	D	M	O	Pre	Post
Experimental	2-A	47	64	6	4	21	4	0	59	61	2	3	34	0	0	-.20	.39
	1-B	59	53	7	27	14	0	0	47	57	2	32	9	0	0	.56	.40

Table 268. Pretest to Posttest Changes (The response choice for 2-A is cited first.)

Item Pair 2-A, 1-B	Percent Change, Pretest to Posttest											
Student Group	Correct Choice			Parallel Distractor Pairs								
	D	A	D+A	A	D	A+D	B	C	B+C	C	B	C+B
Experimental	+13	+4	+5	-3	-5	+2	-4	+5	-3	-1	-5	-3

Objective Achievement Tests

Descriptive Data and Interpretation. Pretests were administered to experimental classes between March 8 and May 14, 1971; no control group was used for Unit IV. Posttests for the experimental group were administered between June 7 and June 18, 1971.

Raw score frequency distributions on the Unit IV tests for the experimental group are shown in Table 269. Table 270 provides a summary of student background data for the ten experimental classes. Table 271 provides more descriptive data on pretest, posttest and residual gain scores. The interpretations that follow are based upon data provided in these tables.

1. Although the number of experimental classes was reduced from 16 to ten, the mean age and WISC IQ scores have not changed significantly from those of the 16 class group.
2. Students using Forms A and B in the experimental classes achieved scores outside of the range of the standard error of measurement for both pretests and posttests, indicating differing degrees of knowledge between classes prior to instruction and after instruction.
3. Posttest reliability was satisfactory for Form B (.73), but slightly low (.64) for Form A. Four of the ten experimental classes showed positive mean residual gain scores. Visual inspection indicates two classes (22 and 27) with extremely high residual gain scores and the remaining classes clustered around the mean score for the experimental group.

Table 269. Frequency Distribution of Raw Scores for Test Forms A and B, Experimental Groups

Experimental Groups				
Raw Scores	Pre A	Post B	Pre B	Post A
19-20		2		2
17-18		6		2
15-16	1	11	3	9
13-14	1	9	5	16
11-12	1	5	9	14
9-10	9	7	8	10
7-8	13	7	20	2
5-6	14		9	
3-4	6		5	1
1-2	2			
0				
Totals	47	47	59	59

Multiple Stepwise Regression Analysis

Experimental Group. *Unit IV*. To determine the effect on posttest scores, if any, of the independent variables, the following question was investigated: "Is there a significant difference in the level of achievement on the posttest among students in EMH classes having different background variables?"

The following independent variables were used to test this question: sex, age, WISC Full Scale IQ, race, teachers' assessment of reading achievement, teachers' assessment of verbal participation, and pretest score. All student scores were pooled and treated as the results of one test.

Table 270. Experimental Group, Student Background Information
Unit IV, *ME NOW*, Growth and Development

		Age in Months						IQ	(WISC)					Race[2]			Reading Achievement[3]						Verbal Participation[4]				
Teacher #	N	M	S	Range	Over 13 yrs	Under 11 yrs	σM	M	S	Range	σM	Over 80	Under 50	1	2	3	R	1	2	3	4	5	1	2	3	4	5
Form A[1] 21	6	138.67	6.62	132-149	0	0	2.70	67.67	9.54	54-80	3.90	0	0	3	3	0	0	3	2	1	0	0	0	1	5	0	0
22	10	126.30	8.71	113-140	0	6	2.75	73.40	8.64	62-84	2.73	3	0	4	3	3	0	2	6	2	0	0	0	7	1	2	0
23	11	141.36	12.09	121-162	0	2	3.65	73.36	11.22	51-88	3.38	2	0	11	0	0	0	3	1	1	5	1	0	0	3	1	7
24	9	132.89	6.47	122-142	0	3	2.16	72.00	7.07	56-78	2.36	1	0	4	1	4	2	2	5	0	0	0	1	1	2	3	2
27	9	144.44	14.96	120-170	1	2	4.99	74.00	5.34	62-81	1.78	1	0	9	0	0	0	1	1	1	3	3	0	1	2	2	4
All A	45	136.58	12.16	113-170	1	13	1.81	72.47	8.52	51-88	1.27	7	0	31	7	7	2	11	15	5	8	4	1	10	13	8	13
Form B[1] 33	12	164.67	15.25	144-186	5	0	4.40	69.25	7.85	55-77	2.27	0	0	12	0	0	0	1	2	9	0	0	1	4	6	1	0
34	10	166.40	12.78	146-185	5	0	4.04	71.80	5.87	64-81	1.85	1	0	7	0	3	1	0	6	2	1	0	0	0	7	2	1
35	12	141.42	6.32	133-154	0	0	1.62	67.08	8.03	51-76	2.32	0	0	6	6	0	0	6	2	4	0	0	0	3	2	4	3
36	10	163.80	10.56	146-175	5	0	3.34	73.10	3.00	69-79	0.95	0	0	10	0	0	0	1	2	2	4	1	1	2	1	1	5
38	12	143.00	7.35	134-153	0	0	2.12	67.42	7.35	44-82	3.31	1	1	4	0	8	2	2	4	1	2	1	1	4	5	2	0
All B	56	155.20	15.49	133-186	15	0	2.07	69.54	8.01	44-82	1.07	2	1	39	6	11	3	10	16	18	7	2	3	13	21	10	9
All	101	146.90	16.84	113-186	16	13	1.68	70.84	8.33	44-88	0.83	9	1	70	13	18	5	21	31	23	15	6	4	23	34	18	22
Boys	70	147.94	18.17	113-186	14	8	2.17	71.51	7.68	51-88	0.92	7	1	46	11	13	4	18	21	17	7	3	1	13	29	15	12
Girls	31	144.55	13.32	120-173	2	5	2.39	69.32	9.59	44-85	1.72	2	0	24	2	5	1	3	10	6	8	3	3	10	5	3	10

[1] Teachers are grouped by the pretest form to which they were assigned, i.e., Form A teachers administered Form A as a pretest and Form B as a posttest.

[2] White = 1, Black = 2, Mexican-American = 3.

[3] R = Readiness, 1 = 1st grade, 2 = 2nd grade, 3 = 3rd grade, 4 = 4th grade, 5 = 5th grade.

[4] Continuum from 1 = Non Verbal to 5 = Very Verbal.

Table 271. Experimental Group Pretest, Posttest, and Residual Gain Data
Unit IV, *ME NOW*, Growth and Development

	PRETEST							POSTTEST						RESIDUAL GAIN				
Teacher #	N	M	M%	S	r	σM	Range	M	M%	S	r	σM	Range	M	S	σM	Range Min.	Range Max.
Form A 21	6	6.17	32.47	2.48		1.01	3-9	10.00	50.00	2.97		1.21	7-14	-1.88	2.41	0.98	-3.91	1.77
22	10	7.30	38.42	2.31		0.73	3-11	15.90	79.50	2.73		0.86	12-20	3.38	2.47	0.78	0.21	7.09
23	11	9.09	47.84	2.77		0.84	6-15	13.91	69.55	3.99		1.20	7-18	0.38	3.35	1.01	-5.35	5.21
24	9	6.00	31.57	2.24		0.75	3-9	10.89	54.45	2.67		0.89	8-15	-0.90	2.24	0.75	-3.79	2.89
27	9	5.56	29.26	1.94		0.65	2-8	14.11	70.55	1.62		0.54	12-16	2.57	1.53	0.51	0.77	5.33
All A	56	6.98	36.73	2.64	0.49	1.86*	2-15	13.27	66.35	3.51	0.64	1.72*	7-20	[illegible]93	3.09	0.46	-5.35	7.09
Form B 33	10	8.83	44.15	2.12		0.61	7-13	12.83	67.52	1.40		0.41	11-15	-0.55	1.68	0.48	-3.04	2.09
34	10	8.50	42.50	2.84		0.90	5-13	12.10	63.68	3.00		0.95	8-17	-1.09	2.15	0.68	-4.35	1.28
35	12	5.50	27.50	1.93		0.56	3-9	9.83	51.73	3.04		0.88	3-15	-1.68	2.67	0.77	-7.11	3.77
36	10	10.60	53.00	3.60		1.14	5-16	13.30	73.15	1.79		0.57	12-17	-0.47	1.49	0.47	-2.60	1.77
38	12	8.50	42.50	2.54		0.73	4-12	13.25	69.73	3.62		1.05	7-19	0.06	3.08	0.89	-4.60	6.09
All B	56	8.30	41.50	3.02	0.60	1.92*	3-16	12.34	64.[illegible]	2.99	0.73	1.83*	3-19	-0.75	2.32	0.31	-7.11	6.09
All	101	7.71	39.53	2.92		0.29	2-16	12.75	65.38	3.25		0.32	3-20	0.00	2.80	0.28	-7.11	7.09
Boys	70	7.90	40.51	3.00		0.41	3-16	12.61	64.66	3.40		0.41	3-20	-0.24	2.85	0.34	-7.11	7.09
Girls	31	7.29	37.38	2.73		0.49	2-15	13.06	66.97	2.91		0.52	7-18	0.55	2.66	0.48	4.60	6.21

*Standard error of estimate (σ_s) for individual scores.

Table 272. Results of Multiple Linear Regression Analysis, Experimental Group, Unit IV. N = 101

Independent Variable	β_i	$S\beta_i$	F
Sex	.1062	.5560	.0364
Age	-.0414	.0169	5.9965*
WISC Total IQ	.0749	.0352	4.5111*
Reading Achievement	1.0495	.2396	19.18**
Verbal Participation	-.2848	.2322	1.50
Pretest	.5314	.0985	29.1360**

*Significant at the .05 level, $F_{.05(1,94)} = 3.95$

**Significant at the .001 level, $F_{.001(1,94)} = 11.68$

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the post-test instrument.

Discussion

The data indicate that sex and verbal participation are not significant predictors of success on the posttest; the F-level for race was insufficient to enter into the regression equation. The pretest and reading achievement are highly significant predictors of success on the posttest (P<.001). Age and WISC Full Scale IQ are also significant predictors of success on the posttest (P<.05). These results indicate that prior knowledge of the concepts measured by the test instrument and the teachers' assessment of reading level were the best determinants of whether or not the experimental group students attained high scores on the posttest. Test analysis shows that only two of the 20 items were aimed at baseline information and that 14 of the 20 items involved cognitive levels higher than recall. There are also more words in the response choices than in previous tests, which could explain why reading achievement was such a high predictor of posttest success. IQ did not attain the high predictive value for Unit IV that it had on all previous tests. Older students achieved slightly higher scores than younger students and girls scored slightly higher than boys. This result was expected since girls reach puberty at an earlier age than boys and most of the girls in the experimental group are at the age of the onset of puberty and should already know or at least feel the need to know more about sexual development than younger girls or boys.

Table 273. Matrix of Correlation Coefficients
Experimental Group, Unit IV

	Age	Total IQ	Race	Reading Achievement	Verbal Participation	Pretest	Posttest
Sex	-.093	-.122	-.084	.232	-.029	-.097	.064
Age		.083	.331	.212	.027	.408	.047
Total IQ			-.076	.374	.357	.330	.482
Race				-.305	-.231	-.227	-.153
Reading Achievement					.441	.190	.486
Verbal Participation						.238	.253
Pretest							.505

Since IQ and reading level are quite highly correlated (.374), much of the variance accounted for by reading level would also be accounted for by IQ. This is a probable cause of the results of the multiple regression analysis.

Table 274. Multiple Stepwise Regression Analysis Experimental Group, Unit IV

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables
1	Pretest	.5049	.2549	.2549	33.8702	1
2	Reading Achievement	.6424	.4127	.1578	26.3354	2
3	Age	.6845	.4686	.0558	10.1935	3
4	Total IQ	.6995	.4893	.0207	3.9001	4
5	Verbal Participation	.7055	.4978	.0084	1.5954	5
6	Sex	.7057	.4980	.0002	.0364	6

The effect of the pretest accounts for approximately 25.5 percent of the variance in the regression equation. The combination of pretest and reading achievement accounts for 41.3 percent and when age is included the total is 46.9 percent. The inclusion of all independent variables except race, whose F-level was insufficient to enter into the regression equation, accounts for 53.5 percent of the variance. This result compares favorably with the results for previous units. The low significance levels for sex, age, and IQ are encouraging.

Objective Achievement Tests

Analyses of Variance and Covariance, Experimental Group, Unit IV. Two statistical tests were performed to investigate the question, "Is there a significant difference between experimental classes in the level of achievement on the Unit IV posttest?" The results of an analysis of covariance are summarized in Table 275 and indicate a significant difference between classes on posttest means adjusted for differences in pretest scores.

Table 275. Analysis of Covariance Between Classes on Adjusted Unit IV Posttest Means, Pretest as Covariate

Source	d.f.	F-Ratio
Between Groups	9	4.8224**
Within Groups	90	

**Significant at the .001 level, $F_{.001(9,90)} = 3.53$

An analysis of variance was also computed between experimental classes with residual gain scores as the dependent variable. Table 276 shows the results of the analysis of variance, indicating a significant difference between classes on residual gain scores. The pretest, posttest, and residual gain means are summarized in Table 271, page 276.

Table 276. Analysis of Variance Between Classes on Residual Gain Scores, Experimental Group, Unit IV

Source	d.f.	Mean Square	F-Ratio
Between Groups	9	28.3863	4.8697**
Within Groups	91	5.8291	

**Significant at the .001 level, $F_{.001(9,91)} = 3.54$

This result confirms that of the analysis of covariance.

Discussion

The results of the analyses of variance and covariance confirmed the results of a visual inspection of Unit IV scores. Classes 22 and 27 were clearly superior to the other classes and apparently classes 21 and 35 were inferior. The time available for instruction in Unit IV could have influenced the results. All other classes are clustered around the mean posttest level.

Analysis of Variance, Experimental Group. The results of the multiple linear regression on the posttest indicated that reading achievement ($P<.001$), age, and WISC Full Scale IQ ($P<.05$) are significant predictors of success on the posttest. The reduced N for Unit IV precludes the possibility of a three-way analysis of variance because of the number of empty cells and the small number of replications per cell that would result. In previous units, only those independent variables from the multiple regression significant at the .01 level and beyond have provided significant differences in subsequent analyses of variance. Because of previous results, residual gain scores were blocked on five levels of reading achievement: readiness and first grade, second grade, third grade, fourth grade, and fifth grade. An analysis of variance was performed on the five levels to determine if there were any significant differences between levels. The following question was then investigated: "Is there a significant difference in residual gain scores between students blocked on five levels of reading achievement?"

Table 277 contains the results of the analysis of variance, indicating a significant difference between reading levels. Table 278 summarizes the N, means, and standard deviations for the residual gain scores in each cell.

Table 277. ANOVA, Residual Gain Blocked on Reading Achievement Experimental Group, Unit IV

Source	d.f.	Mean Square	F-Ratio
Between Groups	4	49.4999	8.0826**
Within Groups	96	6.1243	

**Significant at the .001 level, $F_{.001(4,96)} = 5.11$

Table 278. N, Mean Residual Gain Scores and Standard Deviations for Reading Levels, Experimental Group, Unit IV

Reading Level	N	Mean	Standard Deviation
Fifth Grade	6	1.8376	2.3407
Fourth Grade	15	2.0197	1.8505
Third Grade	23	.1054	2.8004
Second Grade	31	.3360	2.7239
Readiness and First Grade	26	-2.0829	2.1677

Discussion

The analyses of variance were computed on the five reading levels and the results indicate that there is a significant difference in residual gain scores between levels ($P<.001$). Visual inspection indicates three performance levels: fourth and fifth grades, third and second grades, and readiness-first grade, with the tendency for the higher reading levels to achieve higher residual gain scores. As indicated previously, this result is probably due to the increased demand for reading on the Unit IV tests.

Factor Analysis. To determine the structure of the Unit IV achievement tests, a Harris-Kaiser oblique, unnormalized, orthogonal rotation was performed on the results of posttests A and B. For posttest A, 12 factors were identified which accounted for 48 percent of the variance. For posttest B, 13 factors were identified which accounted for 56 percent of the variance.

Table 279 presents the results for posttest A, showing only those factors with eigenvalues above 1. The objective measured and cognitive level of each item is included, as is a hypothetical name for each factor. Table 280 presents the results for posttest B, showing only those factors with eigenvalues above 1.

Table 279. Factor Structure - Unit IV, Posttest A

Factor	Items	Cognitive Level	Objective	Name
1	6	high	404	chapter overview
	7	low	403	
	9	knowledge	400	
2	6	high	404	attitude toward body functions
	13	attitude	401	
	17	attitude	401	
3	4	low	403	conception - fetus development
	12	knowledge	403	
	20	low	403	

Table 280. Factor Structure - Unit IV, Posttest B

Factor	Items	Cognitive Level	Objective	Name
1	8	low	403	conception - umbilicus
	11	high	403	attachment
2	15	knowledge	403	menstrual cycle
3	1	low	Unit II	Unit II recall

Three of the four items found in posttest B factors (with eigenvalues above 1) have their corresponding Form A item in the posttest A factor analysis. Posttest A factors are evenly distributed across the test, but posttest B factors deal almost entirely with objective 403. Since objective 403 was the focal point of Unit IV, the results from posttest B are not surprising.

Summary

Pretest to posttest gains were exceptionally high for Unit IV, indicating a significant effect due to instruction. Students with high reading ability achieved a higher level of success than students at low reading levels. This is attributed to the amount of reading involved in the test itself and not to the instructional program. Achievement test results identified some problems with the items themselves and some instructional problems that have resulted in modifications of the tests and the instructional materials. Teacher feedback has been invaluable in improving the experimental materials. Student interest and motivation for Unit IV has been higher than with any previous unit.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The major purpose of this formative evaluation is to formalize the data and interpretations of data that were provided to the team of writers revising the experimental materials. Specific suggestions for changing and improving are contained within the discussion of each objective within each chapter and will not be repeated in this summary. A general description of outcomes for the entire program are presented first, based on the questions posed in the evaluation model (see Table 1, page 11). The questions are not repeated, but the discussion follows the same sequence. The conclusions, following the summary, are presented unit by unit to point out important results. The concluding section includes the major revisions that were made in the revised materials.

What Were the Results of the Formative Evaluation?

Students in the 1970-71 field test were within the prescribed limits of age and IQ for which the materials were designed. Table 3 (in Chapter I) provides a summary of background variables for students in the experimental group. Table 4 provides this information for students in the control group. These tables also indicate the number of students outside the prescribed IQ and age limits in both groups.

Pretest scores indicated that many students could perform the behaviors specified by the objectives and subobjectives prior to instruction in Unit I. This is by design. The writers wanted the students to experience success early in the program to provide more stimulation and enthusiasm. Nine of 30 Unit I test items provided baseline measures of student achievement. In subsequent units, activities relied less on prior knowledge, and the general trend of baseline type items declined from nine in Unit I to two in Unit IV.

Most teachers reported that they used the strategies as described. A few reported minor modifications and fewer still reported major modifications. No funds were available for either videotaping teacher presentations or for providing classroom observers to verify teacher reports of fidelity to strategies. Experience from the previous year's testing plus data from a limited number of staff visits to test classrooms lead us to doubt the high percentage of fidelity to the strategies reported.

The mean number of hours of instruction for each unit was well within the prescribed time limit of 30 minutes per day, five days per week, lasting from four to six weeks. Under normal classroom conditions, however, and with the goal of teaching for a mastery level of student achievement, *ME NOW* is a full two-year program.

Teacher reports indicated that the overall student success ratio was high on the behaviors specified within the program. Where specific difficulties were identified by teachers or by achievement tests, revisions were made in strategies, materials or procedures.

In Units II and IV, a wide divergence of teacher fidelity to strategies occurred. These were the only units where significant differences were found between classes in the level of student achievement. The evidence indicates that the desired student responses will occur if teachers follow the prescribed strategies.

Teachers' comments on feedback forms were extremely valuable to the revision team in producing the revised edition. In general, teacher reaction to materials and strategies was overwhelmingly favorable. The major problems in materials were encountered with temporary equipment that will be replaced by the functioning torso in the commercial edition. Some problems were also encountered with films, but seven films designed specifically for use with *ME NOW* are available with the commercial edition and should enhance as well as strongly reinforce learning with the revised edition.

It is very difficult for a teacher who is used to lecturing to a class to modify his or her behavior in order to become a guide for student activities. Most experimental teachers made this shift, but in varying degrees. Teachers who were completely successful in changing their behavior indicated a high degree of student enthusiasm and motivation in their new role.

The students' reactions to the materials, according to teacher reports, were overwhelmingly positive. Quotes from teachers regarding student attitudes and reactions are contained in previous chapters and will not be repeated here. Both teachers and developers were extremely well pleased with these results. For most students, *ME NOW* has provided the first opportunity to "put their hands on things," to manipulate equipment and to draw their own conclusions on data they have collected.

Teachers' estimates of the proportion of students able to successfully perform specified behaviors were generally high throughout the program. Where low success levels were reported, an attempt was made to determine if the problem was related to teaching strategies, materials, level of difficulty, etc.; and appropriate revisions were made. Mean total gains from pretest to posttest were achieved in all four units by students in the experimental group, and the posttest level of achievement was satisfactory for all units and spectacular in Unit IV. Gains were evaluated by calculating simple pretest-to-posttest gains, gains from pretest scores to adjusted posttest scores, and residual gain scores. Adjusted posttest scores and residual gain scores were calculated to minimize the effect of a regression to the posttest mean, inherent in any pretest-posttest design. That is, those students scoring high on the pretest will tend to score lower or regress to the posttest mean level of achievement, and those students who scored low on the pretest will score higher on the posttest. This effect occurs without instruction taking place and must be accounted for in the evaluation.

In Units I, II and III, students in the experimental group scored significantly higher on adjusted posttest scores and on residual gain scores than similar students in the control group. No control group was used in Unit IV, but the level of the gains was so spectacular that there was no doubt that instruction had produced a significant effect.

What Were the Major Conclusions from the Evaluation?

1. The data indicate that students learn during exposure to the materials of *ME NOW* and attain levels of achievement that are significantly higher than similar students in a control group not exposed to *ME NOW*.
2. In Units I, II and III, students in the experimental group with WISC Full Scale IQ scores between 67 and 79 attained posttest achievement levels equivalent to or significantly higher than students with WISC Full Scale IQ scores of 80 or above.

3. In Units I, II and III, students in the experimental group with WISC Full Scale IQ scores between 67 and 79 attained posttest achievement levels significantly higher than students with WISC Full Scale IQ scores of 66 or below.
4. In Unit IV, the level of gains from pretest to adjusted posttest scores was far beyond the level expected by the developers, and the achievement level was virtually independent of WISC Full Scale IQ scores.
5. Based on conclusions 1, 2 and 3, we feel that the *ME NOW* materials are suitable for the population of educable mentally handicapped children for whom they were designed.
6. In Units I to IV, pretest scores were the best predictors of posttest scores on the alternate test forms.
7. In Units I, II and III, males attained higher levels of achievement than females although the difference was not statistically significant.
8. In Unit IV, females attained higher levels of achievement than males although the difference was not statistically significant.
9. Race of the students in the experimental group had no determining effect on achievement level. In Units III and IV race did not account for enough variance to enter into the regression equation of the multiple stepwise regression.
10. In Unit IV, teacher's assessment of reading level was a highly significant predictor of success on the posttest. This is attributed to reading involved in the test and not to any reading effect during instruction.
11. A gross ignorance of the process of menstruation was evident among

girls in the experimental group prior to instruction in Unit IV. Since many females encounter the onset of puberty at the age level of 11 to 13, instruction with materials similar to Unit IV of *ME NOW* should be emphasized.

12. The *ME NOW* program is based on a philosophy of teaching through inquiry. Throughout the period of instruction, student success was heavily dependent on teacher fidelity to instructional strategies. In view of these results, we strongly recommend that teachers undergo sufficient training to acquaint them with the philosophy and rationale of the program, prior to attempting any classroom instruction with *ME NOW*.

What Were the Major Revisions Suggested for the Revised Materials?

The following are the major additions to the *ME NOW* materials, in addition to the changes cited in the evaluation of student achievement in the previous chapters.

1. Application and/or extensions to the lessons have been added to help the teacher broaden the effective use of *ME NOW*. Many activities relate directly to health, safety, nutrition, etc., and logical entry points from *ME NOW* have been provided to these areas.
2. Instructional assessments similar to the questions used in the achievement tests have been included at the particular point in instruction where any of the test items measure achievement. In this manner, teachers can assess student achievement on a regular basis and not wait until after completing the unit to find out

if the students have mastered the concepts.

3. Cartoons have been added throughout the guides to remind teachers of appropriate teacher behaviors necessary in inquiry teaching.
4. The teacher's part of the suggested dialogue has been shaded to draw the teacher's attention and facilitate the use of the guide.

Summary

Dr. Gaston E. Blom stated, "Children with handicaps have greater concerns about their bodies, body parts, and body functioning than do normal children. These concerns, both realistic and irrational, influence their self-concepts and many of their behaviors, including learning."

After extensive classroom trials and revisions, we believe that *ME NOW* capitalizes on the concerns of the EMH child and provides an effective program of instruction to help him learn more about his body and how it functions. We are grateful to the U. S. Office of Education, Bureau of Education for the Handicapped, for providing the funds necessary for the development of *ME NOW*.

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[20] Blom, Gaston E. "Some Considerations About the Neglect of Sex Education." The Journal of Special Education, Vol. 5, No. 4, pp. 359-61. (Winter, 1971)

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APPENDIX I. CONTROL CLASSROOM TESTING SCHEDULE

Pretest, Unit I	November 2-6
Posttest, Unit I	January 11-15
Pretest, Unit II	January 11-15
Posttest, Unit II	February 15-19
Pretest, Unit III	February 15-19
Posttest, Unit III	March 29-April 2
Pretest, Unit IV	March 29-April 2
Posttest, Unit IV	May 24-May 28

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APPENDIX II

ME NOW
EMH Life Science
1970-71
Experimental Materials

The formative evaluation of the experimental Life Science materials "Me Now" is designed to secure data to answer a series of questions regarding the characteristics of the students in the trial classes. The class enrollment form is one of the data reporting forms to gain information about the students. All information will be regarded as confidential and used only in the evaluative process of the Life Science program.

Directions for the completion of the class enrollment form.

Top left corner:	Be sure to supply complete information in this section. The information given will help us to keep our files straight and make the recording of data easy to handle.
Top middle:	This information will facilitate contacting you when school is not in session.
Top right:	School district information must be supplied; these data will enable us to describe the experimental population more accurately. Be sure that when you circle a school descriptor, you circle one category in line (a) and one category in line (b).
Column 1:	To facilitate the data processing by a computer, all students will be assigned an I.D. number by BSCS. Student names cannot be used in data processing.
Column 5:	Intelligence test data. If the child has not had a WISC test, enter the Binet test score under total test or other test score that is available and indicate the name of the test given.
Column 6:	Ethnic background. Circle the appropriate group. (1) Caucasian or white; (2) Negro or black; (3) Spanish American or Puerto Rican; (4) other such as Indian or Oriental. If other is circled, please write the ethnic background for the student above the numbers in column 6.
Column 7:	Reading achievement data is your judgment of the child's performance in the classroom

reading you require him to complete. Circle the appropriate grade level that best describes his reading skill. R is reading readiness level, 1 is first grade, etc.

Column 8: Describe in your judgment the student's ability to participate in class discussions. We are interested in your opinion of the student's ability to interact verbally. The scale is arranged so that Low (1) would be a non-verbal student and high would be a student who is able to carry out a good relevant verbal interaction.

APPENDIX II (Continued)

CLASS ENROLLMENT OF E.M.H STUDENTS FOR LIFE SCIENCE FIELD TESTING

TEACHER'S NAME ______________________
last first middle init.

NAME OF SCHOOL ______________________

SCHOOL ADDRESS ______________________
street

SCHOOL PHONE ______________________
city state zip

TEACHER'S HOME ADDRESS ______________________
street

____
city state zip

HOME PHONE ______________________

TOTAL DISTRICT ENROLLMENT ______________________

YOUR SCHOOL'S ENROLLMENT ______________________

THE DISTRICT EMH ENROLLMENT ______________________

SCHOOL DISCRIPTORS (circle one in a and one in b.)
(a) target title I | low income | middle income | upper income
(b) inner city ghetto | urban | rural | suburban

1 ID NUMBER	2 STUDENT'S NAME			3 SEX (CIRCLE)	4 DATE OF BIRTH	5 INTELLIGENCE TEST DATA				6 ETHNIC BACK-GROUND (RACE) (circle one)	7 READING ACHIEVEMENT- (circle one)	8 VERBAL PARTICIPATION (circle one)
	Last	First	Middle			DATE TEST WAS GIVEN	WISC. VERBAL IQ	WISC. PERFOR-MANCE IQ	WISC. TOTAL IQ			Low High
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5
				M F						1 2 3 4	R 1 2 3 4 5	1 2 3 4 5

APPENDIX III

UNIT I
DIGESTION AND CIRCULATION
Teacher ID #________

TEACHER FEEDBACK
QUESTIONNAIRE

Activities 1-3
Pages 1-11

BSCS

1. The materials I had to provide for this section were: (Check all that apply)

hard to get ____
easy to get ____

2. The materials suggested and provided by BSCS were:

satisfactory ____
too fragile ____
too complicated ____
too cluttered ____
not interesting ____
difficult for the teacher to use ____

3. What changes in the materials would you suggest?

(use other side of sheet if necessary)

4. On the following scales, circle the number that describes the way the majority of your class reacted to the activities in this section.

Meaning	High←		Neutral		→Low	Meaning
Interest {attention motivation enthusiasm	5	4	3	2	1	Disinterest {unconcern apathy
Pleasure {enjoyment desire	5	4	3	2	1	Displeasure {dissatisfaction disgust resentment
Willingness {eagerness initiative	5	4	3	2	1	Unwillingness {reluctance averseness

5. Select the statment [by checking (✓)] that most closely describes your teaching strategies.

5a. I used the strategies ____ or 4b. I replaced the strategies ____

as described, no modifications ____, or

with some modification ____, or

with much modification ____.

6. The strategies used were generally unsuccessful ____ or successful ____

6a. Some strategies were (check all that apply):

too simple ____ and/or
too difficult ____ and/or
not interesting ____

Explain your modifications and/or difficulties

(use other side of sheet if necessary)

11A

APPENDIX III (Continued)

Teacher ID #________ TEACHER FEEDBACK QUESTIONNAIRE Page 11B

7. Time Data: Instructional time is an important variable on which we need accurate data. Please complete the blanks as soon after completing an activity as possible.

8. Please rate each activity [by checking(✓)] in terms of importance for your students.

Activity	Minutes per Day	Important OK Useless
1	Day 1___ Day 2___ Day 3___	5___ 4___ 3___2___1___
2	Day 1___ Day 2___ Day 3___	5___ 4___ 3___2___1___
3	Day 1___ Day 2___ Day 3___	5___ 4___ 3___2___1___

9. List and rank order the ID numbers of the three most successful students, in terms of their ability to perform the behaviors specified in #11, opposite.

Activity #1	Activity #2	Activity #3
(best)_________	(best)_________	(best)_________
(2nd best)_____	(2nd best)_____	(2nd best)_____
(3rd best)_____	(3rd best)_____	(3rd best)_____

10. List and rank order the ID number of the three least successful students, in terms of their ability to perform the behaviors specified in #11, opposite.

Activity #1	Activity #2	Activity #3
(least)________	(least)________	(least)________
(2nd least)____	(2nd least)____	(2nd least)____
(3rd least)____	(3rd least)____	(3rd least)____

11. As nearly as you can, estimate what proportion of your students were able to:

12. Please rate each objective [by checking(✓)] in terms of importance for your students.

	All	3/4 or more	1/2 or more	1/4 or more	Less than 1/4	None	Important OK Useless
a. correctly use the chart provided to plot their heights at three ages?	___	___	___	___	___	___	5___ 4___ 3___2___1___
b. suggest the need for a measuring technique or device to determine their present height?	___	___	___	___	___	___	5___ 4___ 3___2___1___
c. interpret the chart as indicating growth over a period of time?	___	___	___	___	___	___	5___ 4___ 3___2___1___
d. transfer knowledge of the previous activity on height to development of the chart on weight?	___	___	___	___	___	___	5___ 4___ 3___2___1___
e. complete the weight chart correctly?	___	___	___	___	___	___	5___ 4___ 3___2___1___
f. interpret the weight charts as indicating growth over a period of time?	___	___	___	___	___	___	5___ 4___ 3___2___1___
g. interpret the cartoons as showing a relationship between food and body growth, development, energy, etc.?	___	___	___	___	___	___	5___ 4___ 3___2___1___
h. explain, in their own words, body functions related to food: growth, energy, etc.	___	___	___	___	___	___	5___ 4___ 3___2___1___

Describe any unanticipated student responses during the activities.
(use other side of sheet if necessary)

APPENDIX IV. OBJECTIVES AND SUBOBJECTIVES

UNIT I. DIGESTION & CIRCULATION

Terminal Objective 100. Students will associate food with generalized body needs.

Subobjective 1. Students will observe evidence of their growth and relate it to food.

2. Students will describe particular uses of food from their own experience.

Terminal Objective 101. Students will associate food types with plant and animal sources.

Subobjective 1. Students will distinguish between animal and plant food sources.

2. Students will identify the animal source of specific foods.

3. Students will identify the part of the plant where specific foods grow.

Terminal Objective 102. Students will recognize differences in physical characteristics of foods.

Subobjective 1. Students will recognize that foods are composed of solids and liquids.

Terminal Objective 103. Students will relate structure with function of mouth parts.

Subobjective 1. Students will associate the teeth with chewing, and the tongue with chewing and tasting.

2. Students will associate the tongue with distinguishing tastes.

3. Students will observe and describe the secretion of saliva in the mouth.

4. Students will relate functions of teeth, tongue, and saliva in the mouth to characteristics of foods.

Terminal Objective 104. Students will relate location of the mouth and stomach to structure and function of the esophagus.

Subobjective 1. Students will observe, describe, and develop ideas about the passage of food from the mouth to the stomach.

Terminal Objective 105. Students will relate stomach functions to digestion.

Subobjective 1. Students will describe external evidence of stomach activity.

2. Students will observe and describe effects of simulating the churning actions of the stomach.

3. Students will observe and describe the solubility of sugars in water.

4. Students will observe and interpret a laboratory test to determine the presence of sugar in a solution.

5. Students will perform and interpret a laboratory test to determine the presence of starch in a food.

6. Students will determine the presence or absence of starch and sugar in a variety of foods.

7. Students will associate "digestive juices" with the conversion of starch to sugar.

8. Students will observe and describe the effects of digestive juices on foods.

9. Students will review and describe the process of digestion from the mouth through the stomach.

Terminal Objective 106. Students will construct inferences about the functions of various parts of the circulatory system.

Subobjective 1. Students will observe external evidence of circulation.

2. Students will locate, observe, and describe evidence of heart activity.

Subobjective 3. Students will associate heart actions with heart sounds.

4. Students will associate heart actions with pulse.

5. Students will associate heart actions with heart sounds and pulse.

6. Students will associate the circulation of blood with heart action and pulse.

7. Students will make and explain a simple diagram of the circulatory system.

Terminal Objective 107. Students will construct an inference about the relationship between food and blood, and describe the barriers between them.

Subobjective 1. Students will trace the pathway of food from the mouth to the intestine.

2. Students will trace the remainder of the digestive tract, and speculate about the fate of digested food in the intestine.

Terminal Objective 108. Students will observe and describe movement of substances through membrane barriers.

Subobjective 1. Students will compare the permeability of a membrane to solids and to liquids.

2. Students will observe and describe movement of substances in solution through two membrane barriers.

3. Students will review and describe the processes of digestion and circulation.

UNIT II. RESPIRATION & BODY WASTES

Terminal Objective 200. Students will infer that breathing is a necessary life process.

- Subobjective 1. Students will associate internal body parts with external evidence of breathing.
- 2. Students will associate internal body parts and external evidence of breathing with the flow of air in and out of the body.
- 3. Students will associate breathing with the exchange of oxygen and carbon dioxide.
- 4. Students will infer that oxygen is necessary for life.

Terminal Objective 201. Students will identify respiration as a necessity for body action.

- Subobjective 1. Students will associate increased body activity with the need for additional food and oxygen.
- 2. Students will associate food and oxygen with muscle activity.
- 3. Students will infer the need for an oxygen/food distribution system to the muscles, and identify the blood as part of that system.

Terminal Objective 202. Students will infer a relationship between waste and internal body processes.

- Subobjective 1. Students will recognize that water and carbon dioxide are products of energy release.
- 2. Students will relate specific excretions to specific regions and actions of the body.

Terminal Objective 203. Students will recognize, recall, and be able to synthesize concepts presented in the Unit.

- Subobjective 1. Students will interpret and explain animated cartoons depicting Unit concepts.

UNIT III. MOVEMENT, SUPPORT, & SENSORY PERCEPTION

Terminal Objective 300. Students will associate bones and muscles with body movement, support, and balance.

Subobjective 1. Students will determine how muscles work.

2. Students will determine how muscles and bones work together.

3. Students will associate body strength and endurance with muscle development.

4. Students will identify protective functions of bones and muscles.

5. Students will determine that muscles and bones are necessary for support and balance.

Terminal Objective 301. Students will associate senses with conscious and unconscious control of body activity.

Subobjective 1. Students will identify the senses.

2. Students will identify senses used in recognizing their surroundings.

3. Students will determine the influence of senses on body activity.

Terminal Objective 302. Students will associate the brain with control of body activity.

Subobjective 1. Students will determine that the brain directs conscious and unconscious activity.

2. Students will determine that brain receives and sends information from and to the body.

3. Students will associate brain-directed activity with learning from previous experiences.

Terminal Objective 303. Students will associate sensory perception with learning and behavior.

Subobjective 1. Students will determine that some perceptions are attitudinal.

2. Students will associate practice with learning.

3. Students will associate learning with behavior.

UNIT IV. GROWTH & DEVELOPMENT

Terminal Objective 400. Students will associate distinctions between the sexes with body parts and characteristics.

Subobjective 1. Students will recognize differences that indicate sex.

2. Students will recognize that people undergo sexual development, and that they do so at different rates and ages.

Terminal Objective 401. Students will identify and distinguish functional roles of organs related to sex.

Subobjective 1. Students will infer adolescent functions of female sex organs.

2. Students will infer adolescent functions of male sex organs.

Terminal Objective 402. Students will infer social roles related to sex.

Subobjective 1. Students will identify peer group relationships.

2. Students will infer their potential roles as parents.

Terminal Objective 403. Students will associate parental roles with the formation and development of a new individual.

Subobjective 1. Students will relate functions of the male and female sex organs to the production of a new individual.

2. Students will associate the period of pregnancy with fetal development, time, and changes in appearance of the mother.

Terminal Objective 404. Students will relate changes in "life's continuum" to human growth and development.

Subobjective 1. Students will infer infant-parent relationships based on infant needs.

2. Students will determine the factors necessary for human growth and development.

3. Students will identify and describe periodic changes in growth, development, and aging.

Terminal Objective 405. Students will account for the phenomena that have contributed to the development of "Me Now."

Subobjective 1. Students will distinguish between characteristics that are inherited and those that are not.